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An introduction to the Global Strategy for Plant Conservation

Global Strategy for Plant Conservation: Australia's National Focal Point

Seed longevity of Australian species

It's time for a Global Strategy for Plant and Fungus Conservation

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SPECIAL THEME: THE GLOBAL STRATEGY FOR PLANT CONSERVATION

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Australasian Plant Conservation

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Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. There will be no special theme for the next issue. General articles on any plant conservation issue are most welcome. **The deadline for the June-August 2014 issue is Friday 9 May 2014.** General articles are also very welcome. Please contact Huw Morgan if you are intending to submit an article: editor@anpc.asn.au.

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Front cover: Seedbank Manager James Wood and Alpine Collector Karen Johnson assessing potential collecting targets growing on the edge of a small tarn above Lake Helios. Cradle Mountain–Lake St Clair National Park, Tasmania. Photo: T. Rudman

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STOP PRESS: Recent news for the Global Strategy for Plant Conservation

At the time of printing, two updates on the Global Strategy for Plant Conservation (GSPC) became available. First, in preparation for the mid-term review of the GSPC, a document detailing global progress towards GSPC targets has been drafted by Botanic Gardens Conservation International (BGCI). This draft is available for review and comment at www.bgci.org/resources/news/1108. Second, a GSPC workshop held in Morocco in early April discussed global progress in implementing the GSPC and introduced the GSPC toolkit (information and links to GSPC-related sites throughout the world), as well as plant conservation in Morocco. Further information on the Moroccan workshop is available at www.bgci.org/resources/news/1106, and the GSPC toolkit can be accessed at www.plants2020.net

From the editor

Huw Morgan

Welcome to the autumn 2014 edition of *Australasian Plant Conservation*! The theme of this issue is the Global Strategy for Plant Conservation (GSPC); an initiative under the Convention for Biological Diversity to focus plant conservation efforts across the globe. A reflection of research and conservation endeavours relevant to the theme is timely as the strategy is currently undergoing mid-term review.

The articles in this issue provide an up-to-date review of the current status of the GSPC globally (Sharrock) and within Australia (West and Knapp), along with a detailed focus on *ex situ* conservation efforts, including seedbanking (Sutherland, Merrit, Cochrane et al., Perrins and Wood), and the maintenance of living collections both within (Perrins and Tapson), and outside (Knapp et al., Richardson et al.) species' ranges. The articles also provide a snapshot of biological and logistical challenges to successful *ex situ* conservation of plant species is also provided, with articles exploring mycological, seed science and genetic issues as well as the realities of Subantarctic fieldwork. These *ex situ* conservation programs address Target 8—just one of the 16 Targets of the GSPC—providing a sense of the scale of work required for this global strategy to be realised. A list of the 16 GSPC Targets, and the five overarching Objectives, are provided on the next page for review and reference.

Finally, Pouliot et al. provide perspective to the issue with an argument for developing a global conservation strategy for plants and fungi combined. This article gives resonance to a message emerging from other articles in the issue; that the co-evolution and interdependence of organisms (in this case, plants and fungi) need to be recognised, understood and applied along the way to conservation success.

I hope that you enjoy this issue of *Australasian Plant Conservation*—the first under my editorship—and I look forward to sharing many more rewarding reports with you over the coming issues.

Introduction to the Global Strategy for Plant Conservation

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Background to the Global Strategy for Plant Conservation

The publication of the *1997 IUCN Red List of Threatened Plants* which documented almost 34,000 plant species (12.5 per cent of the world's known vascular flora at that time) under threat globally was instrumental in raising awareness of the crisis facing the world's plant diversity. By 1999, expert botanists were warning that as many as two-thirds of the world's plant species could be in danger of extinction in the 21st century. As a result, a resolution was passed at the XVI International Botanical Congress in St Louis, USA, and a draft plant conservation strategy was prepared by the botanical community in consultation with a range of international and national stakeholders. This became the Global Strategy for Plant Conservation (GSPC), with its 16 targets to be achieved by 2010. In 2002 the GSPC was adopted unanimously by the Convention on Biological Diversity (CBD), marking the first ever adoption of targets for biodiversity conservation by the international community.

The scope of the GSPC

The GSPC's 16 wide-ranging targets were nested under five objectives. The targets required both species and habitat-based actions, considering both natural and managed landscapes. They addressed the conservation needs of wild plants as well as those of cultivated crops, pastures and forests. Targets on the sustainable use of plant genetic resources linked the GSPC to human livelihood issues and the achievement of other targets and goals, such as the UN Millennium Development Goals. Supporting actions related to education, public awareness and capacity-building were also included.

List of GSPC objectives and targets

Objective I: Plant diversity is well understood, documented and recognized

Target 1: An online flora of all known plants.

Target 2: An assessment of the conservation status of all known plant species, as far as possible, to guide conservation action.

Target 3: Information, research and associated outputs, and methods necessary to implement the Strategy developed and shared.

Objective II: Plant diversity is urgently and effectively conserved

Target 4: At least 15 per cent of each ecological region or vegetation type secured through effective management and/or restoration.

Target 5: At least 75 per cent of the most important areas for plant diversity of each ecological region protected with effective management in place for conserving plants and their genetic diversity.

Target 6: At least 75 per cent of production lands in each sector managed sustainably, consistent with the conservation of plant diversity.

Target 7: At least 75 per cent of known threatened plant species conserved in situ.

Target 8: At least 75 per cent of threatened plant species in ex situ collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes.

Target 9: 70 per cent of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge.

Target 10: Effective management plans in place to prevent new biological invasions and to manage important areas for plant diversity that are invaded.

Objective III: Plant diversity is used in a sustainable and equitable manner

Target 11: No species of wild flora endangered by international trade.

Target 12: All wild harvested plant-based products sourced sustainably.

Target 13: Indigenous and local knowledge innovations and practices associated with plant resources maintained or increased, as appropriate, to support customary use, sustainable livelihoods, local food security and health care.

Objective IV: Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted

Target 14: The importance of plant diversity and the need for its conservation incorporated into communication, education and public awareness programmes.

Objective V: The capacities and public engagement necessary to implement the Strategy have been developed

Target 15: The number of trained people working with appropriate facilities sufficient according to national needs, to achieve the targets of this Strategy.

Target 16: Institutions, networks and partnerships for plant conservation established or strengthened at national, regional and international levels to achieve the targets of this Strategy.

Objectives of the Global Strategy for Plant Conservation

- I: Plant diversity is well understood, documented and recognised.
- II: Plant diversity is urgently and effectively conserved.
- III: Plant diversity is used in a sustainable and equitable manner.
- IV: Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted.
- V: The capacities and public engagement necessary to implement the Strategy have been developed.

GSPC progress to 2010

A detailed review of progress towards the GSPC's 2010 targets was carried out by the CBD Secretariat in 2007–08. This review concluded the strategy provided an effective framework for implementation of plant conservation activities at global, regional and national levels. It also indicated notable progress had been achieved with respect to some targets, but for others, progress was limited. Overall however, it was concluded greater progress had been made than if the strategy had not been in place and it was agreed that the GSPC should be continued into a second phase, from 2010 to 2020. Based on consultations with stakeholders worldwide, and regional workshops in Africa, Europe and North America, a revised set of targets were developed.

The GSPC 2010–2020

In 2010, the 10th Conference of the Parties to the CBD, by decision X/17, adopted the Updated Global Strategy for Plant Conservation 2011–2020. The decision adopting the GSPC invited Parties and other Governments to develop or update national and regional plant conservation targets as appropriate and to align the further implementation of the GSPC with national and/or regional efforts to implement the CBD's Strategic Plan for Biodiversity 2011–2020.

National implementation of the GSPC

Countries have responded to the GSPC in various ways, generally falling into one of two categories:

- Countries which have developed a National Plant Conservation Strategy with a set of national targets more or less mirroring the global targets. Examples of such countries include China, Malaysia, Mexico, Philippines, Seychelles, South Africa and UK.
- Countries which have incorporated GSPC targets into national biodiversity strategies to some extent, but have not developed a specific national response to the GSPC. This category includes Australia and New Zealand.

A Global Partnership for Plant Conservation

The Global Partnership for Plant Conservation (GPPC) was established in 2004 to unite international, regional and national organisations in implementing the GSPC. The partnership aims to provide a framework to harmonise existing plant conservation initiatives, identify gaps requiring new initiatives, and to mobilise the necessary resources. Botanic Gardens Conservation International (BGCI) provides the Secretariat for the GPPC.

By February 2014, 49 national and international institutions had become members of the GPPC, including from the Australian Seed Bank Partnership, Kings Park and Botanic Garden and the New Zealand Plant Conservation Network.

Progress towards the GSPC Targets

A detailed mid-term review of the GSPC is being undertaken by the CBD Secretariat in 2014. This includes collecting information from relevant stakeholders on progress towards targets, and has revealed an impressive suite of activities undertaken at local, national and international levels by a wide range of organisations. Some examples of particular relevance to the botanical community are provided below:

Target 1: (A world flora) A World Flora Online Consortium, led by Missouri Botanical Garden has been established. The Consortium so far has 20 members, including the Australian Biological Resources Study.

Target 2: (Red Listing) While Red Listing at the global level has made slow progress (only 6 per cent of the world's plants have so far been assessed), RBG Kew is leading an effort to produce an interim list of global plant assessments by compiling existing datasets. The interim list (for 2013) includes 58,494 unique plant assessments (16 per cent of all plants). Of these, 43 per cent of plants are classified as 'threatened' with extinction.

Target 3: (Tools and resources) A toolkit to support national and regional implementation of the GSPC has been developed by BGCI (www.plants2020.net). The toolkit includes links to over 500 web-based resources and more than 200 printed documents.

Target 4: (Ecosystem conservation) The Ecological Restoration Alliance of Botanic Gardens, including Kings Park and Botanic Garden and the Royal Botanic Gardens Sydney, is helping to share experiences and raise awareness of the role of botanic gardens in supporting ecological restoration. The Alliance focuses on the use of native species in restoration and draws on the horticultural and propagation skills of botanic gardens.

Target 7: (*In situ* conservation) Many botanic gardens are involved in the *in situ* conservation of threatened species, with a particular focus on the development of integrated conservation strategies, linking *in situ* and *ex situ* approaches.

Target 8: (*Ex situ* conservation) The BGCI's *PlantSearch* database provides a global list of the plant collections of the world's botanic gardens. The database includes over 1 million records related to over 350,000 taxa. The database can be used to monitor progress towards Target 8 at global, regional and national levels. A recent analysis of BGANZ collections has revealed that 56 per cent of regionally threatened plants are maintained in the region's botanic garden collections.

Target 14: (Education) The world's botanic gardens, which together receive an estimated 250 million visitors per year, are a gateway to information on plant diversity. Almost all botanic gardens are involved in education and many focus specifically on educating children, however there are no global statistics on how many people are reached through these programs.

Target 16: (Networks) At the global level, the establishment of the GPPC has made a good start at bringing together the plant conservation community, however greater efforts are needed to engage other relevant sectors. At the national level, there is also still a general lack of cross-sector networks. However, where national responses to the GSPC have been developed, this has helped provide a focus for networking amongst the stakeholders.

Conclusions

The GSPC 2020 provides a coherent set of targets to guide plant conservation action at all levels. Responses at national and regional levels have so far been varied, as has progress towards the individual targets. However, it is generally acknowledged that more progress has been made toward the conservation of plants globally than would have been made without the strategy.

Further information about the GSPC is available at www.plants2020.net. More details on progress towards the GSPC targets will be available from BGCI shortly as part of the mid-term review of the GSPC.

Global Strategy for Plant Conservation: Australia's National Focal Point

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Global Strategy for Plant Conservation 2011–2020

In 2002 the Global Strategy for Plant Conservation (GSPC) was adopted as a programme under the international Convention on Biological Diversity (CBD) following international concern that inadequate emphasis and resources were being directed towards plant conservation. The updated strategy (GSPC 2011–2020) has five main objectives related to improving current knowledge and arresting the continuing loss of plant diversity:

- I: Plant diversity is well understood, documented and recognised.
- II: Plant diversity is urgently and effectively conserved.
- III: Plant diversity is used in a sustainable and equitable manner.
- IV: Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted.
- V: The capacities and public engagement necessary to implement the Strategy have been developed.

Within these five objectives the GSPC includes 16 targets for plant conservation to be achieved by 2020 (see www.cbd.int/gspc/targets.shtml). The global targets provide a flexible framework for the development of national and regional targets, which can be set according to a country's own priorities and capacities. Implementation of the GSPC targets is also carried out within the context of National Biodiversity Strategies and Action Plans (NBSAPs), such as Australia's Biodiversity Conservation Strategy 2010–2030.

National Focal Points

To help enhance implementation of the GSPC, the Conference of the Parties—governing body to the CBD—encouraged parties (i.e. countries) to nominate a person to be their national focal point. The general role of GSPC national focal points is to promote and facilitate implementation and monitoring of the strategy at national level. National focal points are expected to contribute to national implementation of the GSPC, including overseeing identification of national targets and integrating them into national biodiversity strategies and policy, promoting participation of national stakeholders, and facilitating communication between national stakeholders, the CBD Secretariat and Global Partnership for Plant Conservation (an international partnership contributing to implementing the GSPC; see www.plants2020.net/gppc/). Specific responsibilities of national focal points for the GSPC are determined by Parties.

Dr Judy West, Executive Director of the Australian National Botanic Gardens in Canberra, is Australia's national focal point for the GSPC. Other key thematic areas of the CBD related to the GSPC, for which Australia also has national focal points include:

- the Global Taxonomy Initiative
- the Nagoya Protocol on access and benefit-sharing
- protected areas.

These national leadership roles represent a significant contribution to the implementation of Australia's obligations under the CBD, and to the scientific knowledge underpinning the management and conservation of our biological diversity.

The GSPC focal point plays a role in the success of the national implementation of the strategy by:

- bringing stakeholders together
- promoting the development of and/or updating the national plant/biodiversity conservation strategy and targets
- incorporating conservation strategy and targets into relevant policy and initiatives

- sharing information with other countries, including through the GSPC toolkit developed to support national and regional implementation of the GSPC (www.plants2020.net/).

Australia's response to the GSPC

As the national focal point and through the Australian National Botanic Gardens, Judy West aims to raise the profile of the GSPC in Australia, and together with the Council of Heads of Australian Botanic Gardens develop a monitoring framework to enable Australia at the national level to report on progress towards GSPC targets. Australian botanic gardens and herbaria contribute significantly to the implementation of the CBD in Australia and play an important role in achieving GSPC objectives and targets through their *ex situ* collections and the application of expertise in areas such as taxonomy, botanical research, conservation, education and awareness raising, propagation and cultivation.

However, for Australia to respond effectively to the 2011–2020 targets of the GSPC, greater engagement and input from national and local partners is required. Compared to the targets of the initial GSPC (2002–2010), the set of targets to be achieved by 2020 include several which are beyond the remit of botanic gardens or herbaria. For instance, GSPC Target 6 requires 'At least 75 per cent of production lands in each sector managed sustainably, consistent with the conservation of plant diversity'.

Response to such targets will require nationally coordinated effort and information from diverse stakeholders and responsible agencies (including the Commonwealth, but particularly also state and territory conservation and biosecurity agencies). Information relevant to GSPC targets could be held by a wide range of organisations including research institutions, gene banks, non-governmental organisations (local, country-wide and national offices of international NGOs), industry (including mining and forestry), local authorities, indigenous and local communities, and plant conservation experts. To assist with engagement and identification of key information sources, an initial workshop involving some stakeholders is planned for the first half of 2014.

Effectively reporting on national progress towards GSPC targets requires a coordinated understanding of our conservation efforts. Knapp et al. (in this issue) describes a study conducted by the Australian National Botanic Gardens to improve Australia's ability to report on progress against GSPC Target 8 (which focuses on increasing *ex situ* collections as a resource for recovery and restoration efforts). The study establishes a framework for assessing existing plant diversity in *ex situ* collections and setting future directions to enhance our national collections.

Further information

More information about Australia's Biodiversity Conservation Strategy 2010-2030 is available online at: http://www.environment.gov.au/topics/biodiversity/international-activities

More information about the CBD and related initiatives is available online at: http://www.cbd.int/

More information about the GSPC is available online at: http://www.cbd.int/gspc/

A guide to the GSPC is available online at: http://www.cbd.int/gspc/programme/guide.shtml

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The Australian Seed Bank Partnership's contributions to the Global Strategy for Plant Conservation

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Introduction

The Global Strategy for Plant Conservation (GSPC) advocates the establishment of partnerships within the plant conservation community to achieve the GSPC's further targets (Target 16). The Australian Seed Bank Partnership (the Partnership), created in 2009, grew out of the Australian Seed Conservation and Research Network. This network comprised a series of bilateral partnerships between Australian states, the Northern Territory and the international Millennium Seed Bank Partnership to help achieve Kew's 2010 goal of seed banking 10 per cent of the world's plant species. The Partnership is governed by The Council of Heads of Australian Botanic Gardens and is supported by the Australian Government to assist the implementation of Australia's Biodiversity Conservation Strategy 2010–2030 and contribute to Australia's efforts towards achieving GSPC targets.

National contributions

The Partnership has 14 member organisations and is made up of Australia's leading botanic gardens, state environment agencies, and non-government organisations. It is taking a coordinated approach to building a national safety net for Australia's plant species through *ex situ* conservation that will provide options for the future use of these plants (Target 8). The Partnership also works with various associates on a project by project basis and this work contributes to four key GSPC targets (i.e. 10, 12, 14 and 15), which have national implications for the conservation of Australia's native flora.

The Partnership has been an active participant in the national multilateral Myrtle Rust Transition to Management Group, coordinated through Plant Health Australia, which operated from 2011-2013 (Target 10). This group worked to maintain plant species threatened by the recently introduced myrtle rust (*Puccinia psidii*). In addition, the Partnership, along with associates, advocates the development of national standards and guidelines for sustainable collection of wild harvested seed and the development of seed production areas capable of supporting a growing restoration industry (Target 12). Finally, botanic garden members of the Partnership raise awareness and understanding of the importance of plant diversity through their education programs and visitor activities. Australia's eight capital city botanic gardens and 150 regional botanic gardens attract an estimated 13 million visits per year (Target 14).

The Partnership supports the Australian Network for Plant Conservation (ANPC) to deliver workshops and training to plant conservation practitioners and community members (Target 15). Past workshops have included plant conservation techniques, seed collection, storage and use, restoration and translocation of threatened species.

*Alister Hodgman and William Russell climbing Miena cider gum (*Eucalyptus gunnii *ssp.* divaricata*) to collect seeds as part of the Partnership's 1000 Species Project.*
Photo: James Wood, RTBG

Target specific contributions to the GSPC

Members of the Partnership have secured a third of Australia's flora in conservation seed banks with duplicate collections at the Millennium Seed Bank in the UK. These collections include seed from more than 25 per cent of the nation's threatened plants. The Partnership's 1000 Species Project (2011–2020) coordinates targeted seed collection from endangered, endemic or economically significant Australian species not already represented in conservation seed banks, as well as working to enhance the provenance of existing collections by collecting from a larger number of populations of the same plant species and aiming to make collections from a broader geographic range.

During 2012–13, the Partnership banked seed of 155 species previously not represented in Australia's conservation seed banks. Nearly half (49.7 per cent) of these collections were of threatened species, listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or under state legislation. More than half of the collections were from endemic taxa. In addition, *ex situ* collections of 19 threatened species susceptible to cinnamon fungus (*Phytophthora cinnamomi*) were added to conservation seed banks (Target 8).

The Partnership, in collaboration with the *Atlas of Living Australia*, has built the *Australian Seed Bank Online*. This publicly accessible database details records for over 37,000 seed collections and draws on *ex situ* collection data in eight conservation seed banks in Australia. This information is integrated with other relevant data records such as *Australia's Virtual Herbarium* and the spatial layers available through the Atlas (http://asbp.ala.org.au). This distributed database permits data export into other systems such as the World Flora Online project (Target 1) and the Millennium Seed Bank's Data Warehouse and can assist Australia with reporting on its achievements against GSPC Target 8.

Current challenges to GSPC implementation

The Partnership faces two key challenges in its work to contribute to the GSPC targets. First, securing adequate funding to enable the banking of genetically diverse *ex situ* collections of native flora, as well as undertaking the science necessary to increase understanding of the seed biology of native flora. Second, collecting accurate data for reporting on GSPC targets, since appropriate evaluation, monitoring and reporting systems are not currently in place in Australia.

Future plans

The Partnership's business plan sets out a 10-year program to build a national safety net of conservation seed banks (GSPC Targets 8 and 9) to safeguard Australia's flora and facilitate knowledge development and sharing through seed science and complementary research (Targets 3 and 14). The Partnership will continue to build comprehensive *ex situ* seed collections of native flora with an emphasis on threatened and endemic species, and those with economic potential. We will also put our efforts into collecting species from the Myrtaceae, which are susceptible to myrtle rust.

The partnership will continue to develop the *Australian Seed Bank Online* for sharing native species germination information to support on-ground restoration. The project will make this information publicly accessible to benefit a large range of users, including research scientists, the conservation sector and the restoration industry (Target 3). Partners will also work collaboratively on research to bridge knowledge gaps of germination techniques for understorey and ground cover plants, which are important components for ecosystem function. Initially, commencing in 2014–2015, a number of Partner organisations will work on Rutaceae, a key understorey family in Australia. This knowledge will directly help rehabilitation practitioners, land managers and community groups in their efforts to restore and reconnect habitats throughout Australia's diverse landscapes (Target 4).

Concluding remarks

In Australia's federated system of states, partnerships are essential and enable a national coordinated approach to plant conservation for the implementation of the Global Strategy for Plant Conservation. The Australian Seed Bank Partnership brings together diverse expertise to address national plant conservation priorities through *ex situ* conservation, as well as support integrated conservation management. The large vision and ongoing commitment by member organisations and individuals creates a powerful force that goes a long way to contributing to Australia's implementation of the Strategy and addressing national plant conservation priorities.

Acknowledgements

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Seed longevity of Australian species

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Introduction

The collection and storage of seeds in *ex situ* seed banks is a primary strategy for the conservation of plant biodiversity. Seed banks focus on establishing and maintaining genetically and geographically representative collections of seeds that can support activities including rare species conservation, degraded habitat restoration, research, and education programs. In Australia, significant seed banking programs for the conservation of seeds of wild species is undertaken by many agencies under the umbrella of the Australian Seed Bank Partnership (ASBP). These collaborative programs have so far resulted in the collection and storage of seeds of more than one third of Australia's species.

Significant research effort is also undertaken by ASBP to support the utility of these seeds for conservation. A particular focus of some recent research is to understand the longevity of seeds in storage. The longevity of most seeds is known to increase as seed moisture content and storage temperature is reduced. Internationally accepted storage procedures recommend that seeds are dried to around 5–7 per cent moisture content, and then stored at -18 °C. Of course, all seeds have a finite lifespan and even under ideal storage conditions the longevity of seeds varies greatly between species. The effective management of seed banks requires data on seed longevity to assist in many curation tasks, including the prioritisation of species for post-harvest processing and storage, and for the development of seed viability testing cycles.

Comparative seed longevity studies

The ongoing collaborative research of the ASBP is focussed on assessing the longevity of seeds of Australian species, and examining seed, plant, and environmental traits that might correlate to seed longevity. This work has adopted the approach of controlled ageing whereby seeds are stored under warm, moist conditions to induce viability loss within weeks or months. Seeds are retrieved at regular intervals and the viability of the seed population is determined by a germination test. For each species, the time to 50 per cent viability loss is determined using statistical techniques, and this time period (designated p_{50}), is used to compare and rank the seed longevity of each species, relative to the others. This method of controlled ageing of seeds, usually undertaken by storing seeds at 60 per cent relative humidity at a temperature of 45 °C or 60 °C, has been employed in a number of laboratories around the world and is providing a growing list of species whose longevity can be compared.

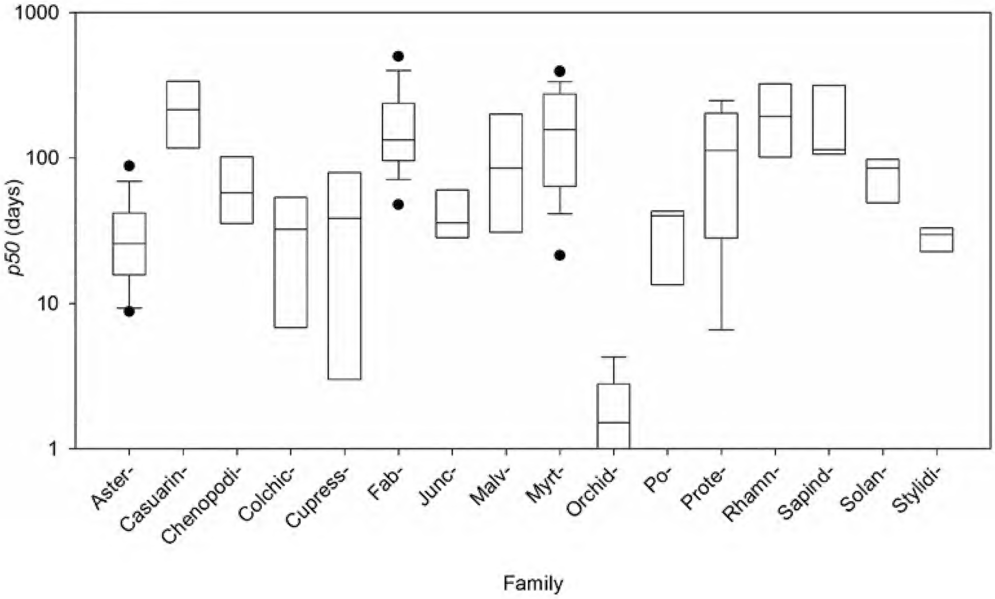
Seed longevity of Australian species

A recently completed data set incorporates seeds of nearly 200 species from across Australia, including species from Western Australia, South Australia, New South Wales, and Queensland. The seeds were selected from species originating in areas with Mediterranean, temperate, arid, and sub-tropical environments and encompass 44 plant families and a wide variation in seed and parent-plant traits. The study aimed to inform conservation seed banking programs and to test recent hypotheses proposing that certain seed traits (e.g. presence/absence of endosperm – tissue within a seed providing nutrition to the embryo) and climatic traits (e.g. rainfall and temperature) are predictors of long- or short-lived seeds.

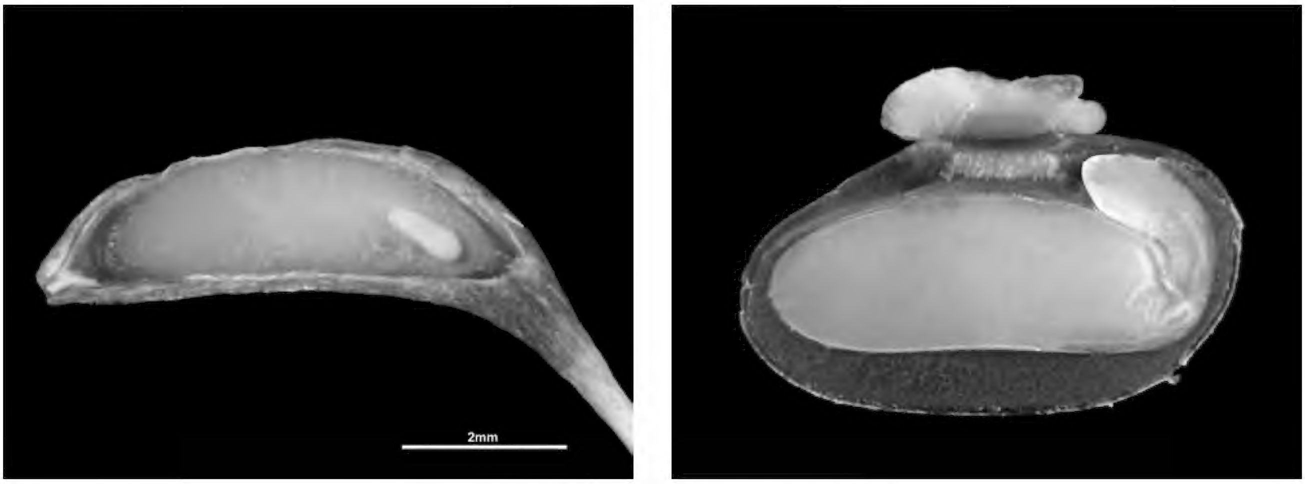
Within this data set, seed longevity varied by four orders of magnitude, with p_{50} values ranging from 3 days - 588 days. At the family level, species of the Casuarinaceae, Fabaceae, Myrtaceae, Rhamnaceae, and Sapindaceae comprised species with the longest-lived seeds. Species of the Asteraceae and Poaceae tended to have short-lived seeds. Most noticeable amongst the short-lived seeds were those of the Orchidaceae, which appear to be the shortest-lived of all species yet found.

Comparing seed longevity with various seed, plant, and environmental traits revealed a few trends. A new finding was that the seed dispersal mechanism of the parent plant was very significantly correlated with seed longevity. Serotinous species (species that retain their mature seeds in protective, woody capsules in the plant canopy), with a mean p_{50} value of 173 days, were almost twice as long-lived as geosporous species (species that release their mature seeds into the soil seed bank), with a mean p_{50} value of 91 days. Seeds from shrubs or trees (p_{50} = 153 days) also tended to be longer-lived than seeds from other plant life-forms, such as herbs and forbs (p_{50} = 34 days). In terms of seed traits, seeds that have small embryos and copious amounts of endosperm (p_{50} = 61 days) were usually shorter-lived than seeds with little or no endosperm (p_{50} = 136 days). This finding in particular is consistent with that of another study of seed longevity of species sourced from across the globe (Probert et al. 2009).

In terms of climatic conditions representative of the habitat of each species, temperature and rainfall were associated with longevity, but only very weakly. Longevity tended to increase as mean annual temperature and mean annual rainfall increased. With respect to temperature, a similar correlation to longevity has been found previously



Box plots of the longevity of seeds (p50) stored under controlled ageing conditions of 45 °C and 60% RH. Boxplots show the 25th to 75th percentiles, whiskers span the 10th and 90th percentiles, and circles span the 5th and 95th percentiles. Box plots comprise data for 183 species.



Seeds with small, underdeveloped embryos tend to be shorter-lived than seeds with large, fully developed embryos. Here, the small embryo of a Clematis linearifolia *seed is clearly visible (left), surrounded by the endosperm tissue. These types of embryos must grow inside the seed prior to germination, with the growing embryo fed by nutrients from the surrounding endosperm. Compare to the seed of Running Postman (*Kennedia prostrata*) (right) which has a fully developed embryo and little surrounding endosperm. Photos: Arielle Fontaine, Lydia Guja*

(Probert et al. 2009; Mondoni et al. 2011), and it seems likely that species in warmer regions generally produce longer-lived seeds than species in cooler regions. However, with respect to rainfall, these previous studies found that rainfall was negatively correlated to seed longevity. Whilst an ability to predict potential longevity based on climatic averages is appealing, there are some confounding factors. For example, rainfall during the period between flowering and seed set has been recently found to be slightly more strongly related to p_{50} values, as opposed to total annual rainfall (Mondoni et al. 2011).

In comparison to species from other regions of the world, seeds of many Australian species have proven to be long-lived. Approximately 16 per cent of the Australian species tested have p_{50} values that exceed 200 days, and of more than 500 species tested across the globe (e.g. Probert et al. 2009; Mondoni et al. 2011) only Australian species have been found to have p_{50} values > 200 days. Importantly however, this doesn't mean that all Australian species should be viewed as long-lived. More than 10 per cent of species tested have p_{50} values of less than 15 days, placing them in a category considered to be short-lived.

Conclusion

This study has provided comparative data for seed longevity across the dominant plant families of the Australian flora. Seeds of Australian species from Mediterranean, temperate, and arid climates are amongst the longest-lived yet found world-wide. Whilst this is promising for the long-term conservation of biodiversity, it is important to recognise that seed longevity still varies by four orders of magnitude, and prolonged seed longevity should not simply be presumed. Partners of the ASBP continue to pursue this research to inform the management of seed banks storing phylogenetically diverse wild species.

Further reading

Merritt, D.J., Martyn, A. J., Ainsley, P., Young, R.E., Seed, L.U., Thorpe, M., Hay, F.R., Commander, L.E., Shackelford, N., Offord, C.A., Dixon, K.W. and Probert, R.J. (2014). A continental-scale study of seed lifespan in experimental storage examining seed, plant, and environmental traits associated with longevity. *Biodiversity and Conservation* (In press; DOI: 10.1007/s10531-014-0641-6).

Probert R.J., Daws M.I. and Hay F.R. (2009). Ecological correlates of *ex situ* seed longevity: a comparative study on 195 species. *Annals of Botany* 104: 57-69.

Acknowledgements

Many people contributed this study including Amelia Martyn, Phillip Ainsley, Renee Young, Leahwyn Seed, Michael Thorpe, Fiona Hay, Lucy Commander, Nancy Shackelford, Catherine Offord, Kingsley Dixon, and Robin Probert.

What are we conserving? Living collections contributing to Target 8 of the Global Strategy for Plant Conservation.

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Introduction

Target 8 of the Global Strategy for Plant Conservation (GSPC) sets an aspirational goal for Parties to have 'at least 75 per cent of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes.' Assessing Australia's progress towards meeting this target requires a sound understanding of the plant species diversity held in *ex situ* collections (e.g. living collections, seed banks), and a coordinated strategy to direct future collections. Since genetically diverse plant resources are generally required for successful recovery programs, it is also important to determine how representative *ex situ* collections are of existing genetic diversity in wild populations.

Botanic gardens have an increasingly prominent role in the long-term preservation and recovery of plant species due to their expertise in cultivation of native plants, seed and germplasm storage, and ability to apply these skills to restoration. Historically, botanic gardens paid little attention to genetic diversity; however, their evolving conservation role provides new opportunities to enhance the genetic diversity represented in *ex situ* collections. Assessing the genetic representativeness of *ex situ* collections is tricky as there is no broadly agreed methodology for targeting, capturing or recording this diversity and many records do not distinguish between extant and extinct populations. It is unknown how representative *ex situ* collections are of extant and extinct wild populations, and there is a need to plan the way collections should be structured and prioritised to secure key genetic diversity. Given the cost and time required to undertake genetic testing, a proxy for genetic representativeness can be used in terms of the relative number of source plants and populations from which *ex situ* collections originated.

This project involved a preliminary assessment of the genetic representativeness of the Australian National Botanic Gardens' (ANBG) collections of threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). While seed banking plays an important role in conserving plant species, this project focused on living collections as an initial step in developing this assessment protocol. This initial research provides a foundation for informing decisions about future directions of Australian *ex situ* collections and developing a coordinated effort for measuring national progress toward achieving Target 8 of the GSPC.

Methods

The genetic representativeness of living collections of EPBC listed threatened species at the ANBG was investigated using data obtained from ANBG's Integrated Botanical Information System and the Atlas of Living Australia. Data recording provenance, propagation history and current location of each species were examined to determine the number of:

- individual plants in the garden
- genotypes the living collection holds
- known original source populations.

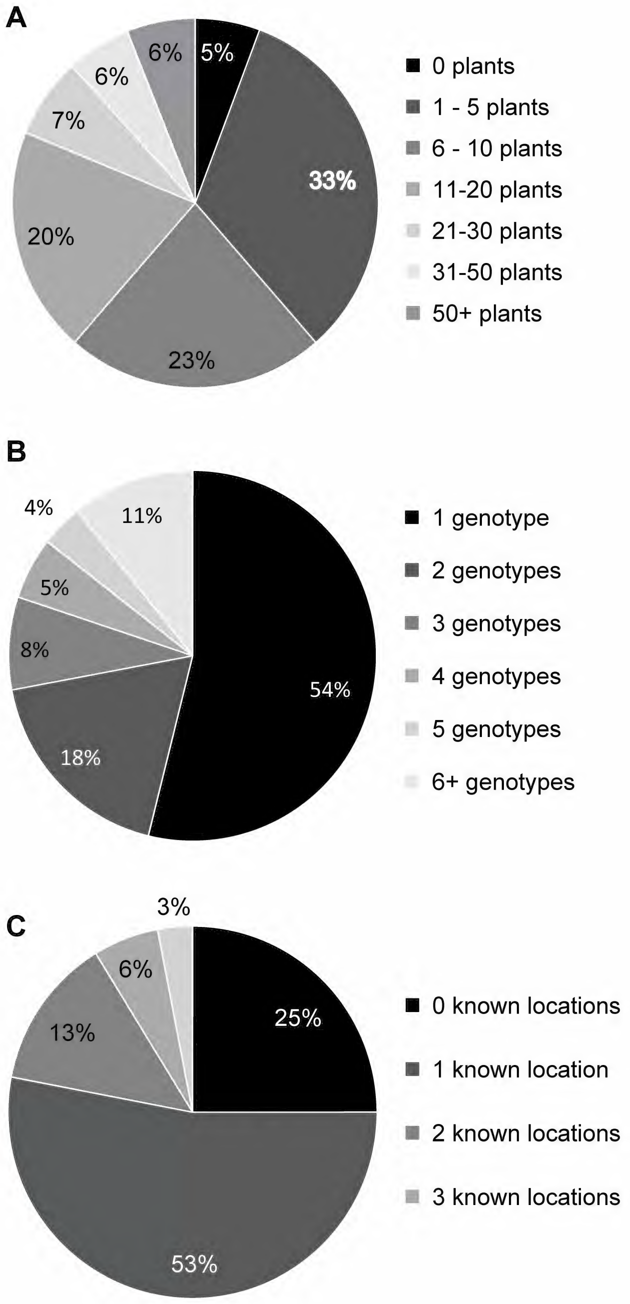
Genetic representativeness was estimated from the number of original source plants, populations and type of germplasm collected (seed or cuttings). For each species this was then compared with historic wild distributions, ascertained from digitised Australian herbarium records. For the purposes of this project, genotypes were defined as an original source plant and all plants clonally propagated from that original plant. Plants propagated from seed were considered distinct genotypes.

Results

ANBG living collections included 298 EPBC-listed plant species from 60 families, equivalent to about 5 per cent of the total of approximately 6000 species at ANBG. There are 4700 individual threatened plants in the garden and 1200 under propagation in the nursery. This equates to 24 per cent of EPBC-listed plant species and a third of the 75 per cent aspired to under Target 8.

Of the 298 threatened species in the ANBG's living collections:

- 61 per cent are represented by ten or fewer plants; 33 per cent by one to five plants; and 5 per cent are represented only in nursery cultivation (i.e. no established plants).
- 54 per cent are represented by a single genotype; 80 per cent by three or fewer genotypes.
- 53 per cent were sourced from one known location; and fewer than 25 per cent were sourced from more than one known location.



Representativeness of EPBC listed species in ex situ collection at the ANBG, in terms of the percentage of species represented by: (a) number of plants; (b) number of genotypes; and (c) number of source original wild populations.

Discussion

The ANBG's living collections include approximately one third of all of Australia's plant species, and 24 per cent (298) of the 1255 species listed under the EPBC Act. This represents a substantial contribution to *ex situ* collections in Australia and to achieving GSPC Target 8. However, the genetic representativeness of these living collections is generally poor, with the majority of species (80 per cent) represented by three or fewer estimated genotypes. This demonstrates the need to enhance the diversity of living collections. Knowing what we have in *ex situ* collections is an important first step to identifying priority species for enhancing collections, and for identifying those species which require urgent research to develop successful horticultural, seed storage or germination protocols.

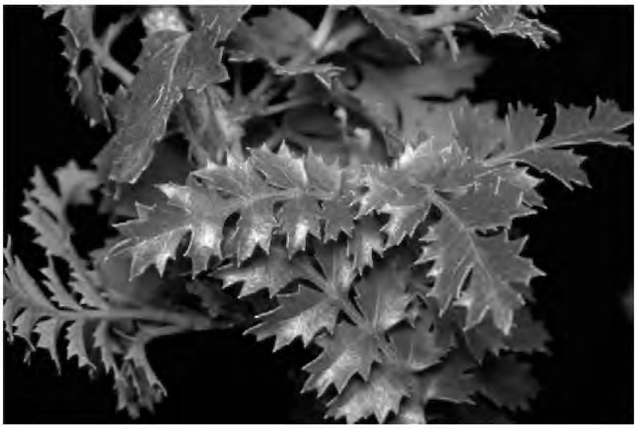
While further research is often required to develop successful recovery programs (e.g. to understand species' ecological requirements and population genetics), botanic gardens can play an important role in preparing species to be 'recovery ready'(e.g. Guja et al. 2013). In addition to holding *ex situ* collections, living collections involve development of specialist horticultural knowledge required for seed germination, plant propagation and establishment. For example, the pioneering work that integrates knowledge about risks of genetic erosion in small populations of small purple-pea (*Swainsona recta*), into a collaborative translocation program (Buza et al. 2000). www.anbg.gov.au/gardens/whatson/news/spring13_story.html.

Assumptions were made in this research about what constitutes a single genotype. While detailed genetic testing and breeding system research would provide a stronger basis for assessing genetic representativeness of *ex situ* collections, these are comparatively expensive. In the interim, this research demonstrates the use of a proxy to provide fast and effective assessment of representativeness and enables additional information to be incorporated as it becomes available. The research relies on accuracy and currency of database records, highlighting the importance of providing and maintaining high quality data, and the role these can play in conservation and recovery programs.

Conclusions

Substantial effort is required for Australian institutions to ensure their *ex situ* collections meet international conservation targets. Achieving GSPC Target 8 will require a coordinated national effort, to which botanic gardens can make significant contributions. Identifying and sharing information about the representativeness of *ex situ* collections will provide the basis for planning and prioritising future development of *ex situ* collections, as well as securing reliable plant material for translocation projects, with more efficient use of resources.

The protocol developed to assess the genetic representativeness of ANBG's living collections can be further refined and expanded to include *ex situ* collections in the seed bank, and applied to *ex situ* collections of other Australian botanic gardens. This will strengthen partnerships between institutions managing *ex situ* collections and assist Australia in meeting national responsibilities towards achieving international targets such as GSPC Target 8.



*King's lomatia (*Lomatia tasmanica*), which exists as a single genotype in the wild, is currently being cultivated in a collaborative effort between the ANBG and the Royal Tasmanian Botanical Gardens. Photo: Murray Fagg, Australian National Botanic Gardens*

References

Buza, L., Young, A. and Thrall, P. (2000). Genetic erosion, inbreeding and reduced fitness in fragmented populations of the endangered tetraploid pea *Swainsona recta. Biological Conservation* 93: 177-186.

Guja, L., North, T., Taylor, D. and McAuliffe, J. (2010). Sowing seeds: bridging the gap between ex situ collections and reintroduction. *Australasian Plant Conservation* 21(3): 14-17.

Acknowledgements

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Addressing Target 8 of the Global Strategy for Plant Conservation in Western Australia

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The Global Strategy for Plant Conservation (GSPC) was adopted in 2002 at the sixth meeting of the Conference of the Parties to the Convention on Biological Diversity to address the global decline in plant diversity. Sixteen outcome-oriented targets were to be achieved by 2010. One of these targets (Target 8 of the GSPC) embraced *ex situ* collections and the link to their use in recovery and restoration. The target called for at least 60 per cent of threatened plant species to be in *ex situ* collections, preferably in the country of origin, and at least 10 per cent included in recovery and restoration programs.

Seed conservation and translocation in Western Australia

In Western Australia (WA) there are currently 12,257 native plant taxa; 3366 of these are rare, threatened or poorly known, of which 413 are listed as 'threatened' under the state's *Wildlife Conservation Act 1950*. Based on IUCN criteria 153 are Critically Endangered, 119 Endangered and 141 Vulnerable. *In situ* conservation approaches involving protection and management of habitat, and amelioration of threats provide the focus for conservation efforts, however *ex situ* conservation has become an increasingly important part of conservation efforts. In particular, *ex situ* conservation of seeds and their use in supporting the survival of wild plant populations through translocation play an increasingly significant role. The *ex situ* storage of seed also offers insurance against loss of genetic diversity where threats to local populations are projected to lead to local extinction.

Since 1992, the WA Department of Parks and Wildlife has maintained the Threatened Flora Seed Centre (TFSC), a dedicated long-term seed storage facility for threatened native species. Whilst this facility was initially established to store species under immediate threat from cinnamon fungus (*Phytophthora cinnamomi*) dieback, it was subsequently expanded to cover all the State's threatened species involving a much broader range of threats, including habitat fragmentation, feral herbivores and invasive plants. However, it became clear that the conservation of a number of Critically Endangered species would require a more interventionist approach than relying solely on the *in situ* protection of populations and conservation of seed. Thus in 1998, a threatened flora translocation program was implemented for reintroductions, introductions and population augmentation.

The activities of *ex situ* conservation and translocation embraced within Target 8 helped to stimulate and focus *ex situ* plant conservation efforts globally. This was highlighted with the launch of the Royal Botanic Gardens, Kew's Millennium Seed Bank Project. Whilst WA already had an active *ex situ* conservation and translocation program targeting the state's threatened plant species, the involvement in this international seed conservation project between 2001 and 2010 allowed for the continuation of this program and the expansion of collecting targets to encompass other conservation significant species.

By 2010, seed of 75 per cent of WA's threatened species had been collected for *ex situ* conservation, with more than 10 per cent of these collections in translocations (41 species). These achievements met the outcomes of Target 8 of the GSPC (2002–2010).

A revised GSPC Target 8

The GSPC raised the profile of plant diversity and inspired numerous initiatives to conserve wild plants, despite many targets not being met (Secretariat of the Convention on Biological Diversity 2009). To continue the momentum, the GSPC targets were revised to cover plant conservation activities and goals from 2011 to 2020.

Target 8 had already provided significant impetus for organisations to link *ex situ* conservation with the *in situ* management of threatened species. The target provided goals for *ex situ* conservation, and connected these activities with recovery and restoration actions that could improve *in situ* conservation. The updated goals now call for at least 75 per cent of threatened plants in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programs. The target doesn't explicitly specify the extent *ex situ* collections should be representative of a species, although the target aims for '… a comprehensive program of *ex situ* conservation that complements *in situ* conservation through the use of genetically representative collections and measures to mitigate threats in the wild and/or strengthen responses to the potential impacts of climate change'. Whilst target levels have increased to take into account the growing number of species likely to require interventions such as translocation, the focus has changed from the 'inclusion' of *ex situ* collections in recovery and restoration programs to simply being 'available' for these programs. The rationale for this change is that translocation is not always necessary or appropriate.

Progress towards the updated Target 8 in Western Australia

By February 2014 the TFSC collections already exceeded the broad goals of the updated target, with samples of 79 per cent of WA threatened plant species held in secure storage. Furthermore, all collections are 'available' for use in recovery and restoration. More importantly, these *ex situ* collections have already supported the translocation

*McCutcheon's Grevillea (*Grevillea maccutcheonii*): from seed in the seed bank to seedlings grown for translocation.*
Photos: A. Crawford

of 58 species to 97 secure sites. While many of these collections can be utilised in translocation programs some have limited use because of limited seed for propagation or because of low quality. These issues are an inevitable consequence of the poor condition of many threatened plant populations. Small population size, reduced reproductive output and reduced seed quality are typical of many of these species.

If translocation is deemed an appropriate approach for species recovery, then the amount of seed in *ex situ* collections may need to be increased. For some species, cultivation with the aim of seed production is likely to be a more viable approach for increasing seed numbers. Seed quality in terms of genetic representativeness and germinability is also an important indicator of the utility of a collection. The development of a tool by which the adequacy of existing *ex situ* seed resources can be measured is required. This would incorporate both seed quantity and seed quality and would be used to set collection targets both between species and within populations of a species and will be used to prioritise future collection activity.

If *ex situ* collections are to provide a reliable resource for future species recovery, monitoring of collection viability becomes critical. As the number of *ex situ* collections increases, the scale of work required to maintain and monitor the collections also increases. Unfortunately most resourcing related to *ex situ* seed conservation focuses on collection intake whilst resources for maintenance remain the same or decline.

Global challenges

Whilst the GSPC provides a useful entry point for countries to address issues related to plant conservation, the targets are aspirational for many. However, as shown in WA, targets can be achieved and even exceeded. The challenge worldwide is to integrate the delivery of the new GSPC targets with national, regional and local conservation plans and actions. In many countries, including Australia, limited resourcing plagues *ex situ* programs. Nevertheless, the Australian Government has committed to pursuing the GSPC targets wherever possible. In particular, members of the Australian Seed Bank Partnership (ASBP), a national seed conservation effort (www.seedbankpartnership.org.au), are working towards achieving Target 8 goals. In WA, Target 8 has provided a useful framework by which the Department of Parks and Wildlife can measure and report the success of its *ex situ* seed conservation and plant translocation programs, including raising awareness of challenges in threatened species management and more broadly in flora conservation issues.

References

Secretariat of the Convention on Biological Diversity (2009). *The Convention on Biological Diversity Plant Conservation report: A Review of Progress in Implementing the Global Strategy for Plant Conservation.* pp 48.

Global Strategy for Plant Conservation and the National Arboretum Canberra

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In December 2003 the Australian Capital Territory Government dedicated a large area of burnt-out radiata pine (*Pinus radiata*) plantation, known as Green Hills, as the site for an innovative new national arboretum. The National Arboretum Canberra has since been developed on a 250 ha site at the western end of Lake Burley Griffin, about 6 km from the centre of Canberra. The first trees were planted in 2007 and the National Arboretum opened to the public in February 2013. As a national institution, the National Arboretum is already playing a role in supporting the Global Strategy for Plant Conservation (GSPC) and in particular, GSPC Targets 14 and 8.

GSPC Target 14

The winning design for the National Arboretum, '100 Forests and 100 Gardens', prepared by the landscape architects Taylor, Cullity and Lethlean, focused on the establishment of 100 forests of rare, threatened and symbolic trees from Australia and around the world. Ninety four of the forests have been planted so far, actively supporting the GSPC's Target 14 to promote 'the importance of plant diversity and the need for its conservation incorporated into communication, education and public awareness programmes'.

The National Arboretum not only cultivates rarely known species, but also highlights the fact that many of the world's commonly cultivated trees are threatened in the wild. In developing the collection of threatened species, the National Arboretum frequently collaborates with international conservationists. This assists in communicating the goals and vision of the National Arboretum to an international audience, as well as providing a showcase for the work of conservationists from around the world. For example, the seed for the Lebanese cedar (*Cedrus libani)* planted at the National Arboretum was collected at the Al Shouf Cedar Nature Reserve in Lebanon by the Lebanese Agricultural Research Institute which is involved in Lebanese cedar conservation. The seed was passed on to the National Arboretum via the Millennium Seed Bank in Kew, UK. By doing so, it has provided opportunities to promote both the conservation of the species in Lebanon and the importance of Al Shouf Cedar Nature Reserve through interpretation.

Although the Arboretum has only been open for one year, members of the Canberra community have already become closely involved in helping to monitor the growth of the trees and interpret the Arboretum, with a one and a half hour guided walk on plant conservation.

Conservation walks being led by trained volunteers at the National Arboretum Canberra. Photo: L. Muldoon

Since the National Arboretum was established, a number of international dignitaries have planted trees. The domestic and international media coverage accompanying these ceremonial plantings promotes the importance of global tree conservation and provides a powerful avenue for disseminating the conservation stories of particular tree species and the work underway to preserve their populations.

GSPC Target 8

The GSPC Target 8 is for 'at least 75 per cent of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes'. While the primary role of the National Arboretum is to promote the importance of plant diversity and the need for its conservation, it also contributes to GSPC Target 8 by providing *ex situ* conservation for a number of threatened tree species from Australia and around the world.

About 20 per cent of the forest plantings are indigenous, including seven rare or threatened *Eucalyptus* species. These are Queensland white gum (*Eucalyptus argophloia*), Camden white gum (*E. benthamii*), weeping snow gum (*E. lacrimans*), Hillgrove spotted gum (*E. michaeliana*), Morrisby's gum (*E. morrisbyi*), small-leaved gum (*E. parvula*) and Wallangarra white gum (*E. scoparia*). The oldest eucalypt forest, Camden white gum (planted in 2007), has already started producing seed.

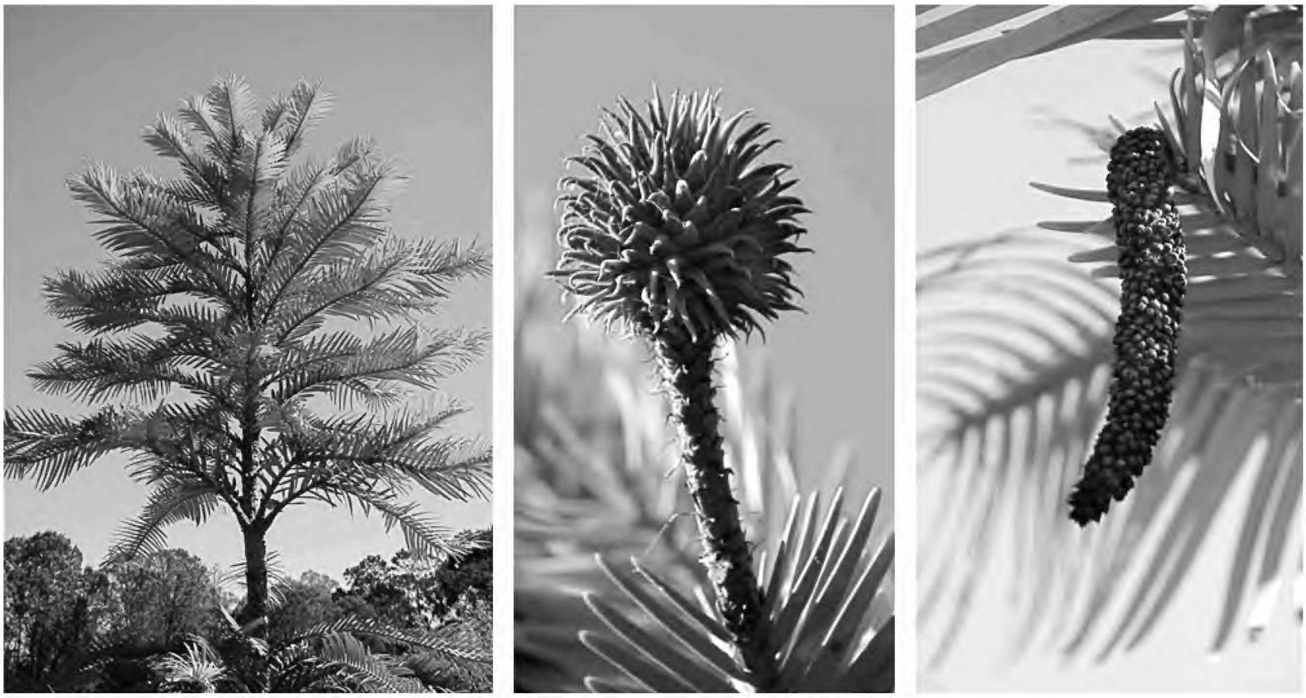
Hybridisation is a problem for arboreta wishing to use seed for species conservation, however, the design of plantings at the National Arboretum reduces the likelihood of hybridisation in two main ways. First, eucalypt species, for example, have been separated from each other by at least one forest of a non-eucalypt to minimise transmission of pollen between eucalypt forests. Second, the large monocultural plantings further reduce the likelihood of hybridisation, particularly for the trees deeper within the stands.

Another notable indigenous species in the National Arboretum is the Wollemi pine (*Wollemia nobilis*). Since the first planting at the National Arboretum in 2007, much has been learned about the growing, and associated *ex situ* conservation, of this genetically limited species. There is considerable landscape variation on the site where the trees are growing and the impact of that variation is already apparent in the growth of trees.

The only part of the area that appears to be suitable for growing Wollemi pine is steeper, facing south and on the edge of a rock outcrop. In that relatively small area some of the trees planted in 2007 are now over 3 m high and have already produced seed. Outside that area, many have died. While this species is not exposed to Canberra's climatic extremes in its present-day range, a planting like this demonstrates the potential for healthy *ex situ* collections to be developed in climatically challenging locations under the appropriate conditions.

In line with GSPC Target 8, one of the National Arboretum's roles is to grow threatened exotic species in Canberra (and its particular climatic conditions) and gather horticultural information that may assist their *ex situ* conservation generally.

Two species currently being trialled are Taiwanese trident maple (*Acer buergerianum* ssp. *formosanum*) and Spanish birch (*Betula pendula* ssp. *fontqueri*). Both have been sourced from wild populations with the former coming from northern Taiwan and supplied by the Taipei Botanic Gardens and the latter coming from the Sierra



*From left to right: Top of a Wollemi pine (*Wollemia nobilis*) at the National Arboretum Canberra; leaves and female cone of a Wollemi pine; leaves and male cone of a Wollemi pine. Photos: L. Muldoon*

Nevada National Park, Granada, Spain. Both subspecies are considered in danger of extinction with Taiwanese trident maple threatened by the uprooting of whole plants for ornamental use. Of the two threatened subspecies, Taiwanese trident maple has already started to set seed and it is planned that seed will be offered back to the Taipei Botanic Gardens to add to their seed collection. The photograph shows that the trees are seeding extremely well and should continue to provide a valuable *ex situ* collection for some time.

*Seeds of the threatened Taiwanese trident maple (*Acer buergerianum *ssp.* formosanum*) on trees at the National Arboretum Canberra. Photo: L. Taafe*

When seed was being sought for the threatened species to be planted at the National Arboretum, seed from wild collections was obtained whenever possible. The large amount of seed required for the size of the arboretum plantings greatly increased the likelihood of genetic variation within the population.

Of the eucalypt plantings, four species, including Camden white gum, have come from wild collections at the CSIRO Australian Tree Seed Centre and one from a wild collection at the ACT's Yarralumla Nursery. In the case of some plantings, for example, the California fan palm (*Washingtonia filifera*), seed was collected from more than one population.

Although the National Arboretum Canberra has only been open for one year, its visitation and level of community involvement has already shown the strong role that it could play in increasing people's understanding of plant conservation. In addition, the inevitable loss of some trees will be an opportunity for the National Arboretum Canberra to replant individuals from a range of known populations, further developing genetic diversity within plantings and enhancing *ex situ* conservation of rare, threatened and symbolic trees.

Working towards securing plant biodiversity in Tasmania

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It is estimated one in five plant species globally are threatened with extinction. Most of the protected areas across the globe are small, fragmented and vulnerable to threats such as climate change, invasive species, natural disasters and political instability. In Tasmania, one fifth of the vascular plant species are threatened. In an era of rapid climate change plant species will have to either migrate to more favourable areas, adapt to the changing conditions or face extinction.

The Tasmanian Seed Conservation Centre (TSCC), located at the Royal Tasmanian Botanical Gardens (RTBG), was set up in 2005 as a partnership between The RTBG, Tasmanian Herbarium, Tasmanian Government Department of Primary Industries, Parks, Water and Environment, and The Seed Conservation Department of the Royal Botanic Gardens, Kew (UK). Seedbanks aim to collect seeds for long-term storage, research and restoration programs and these *ex situ* collections can act as insurance should species become extinct in the wild. Banking seeds is recognised as a scientifically proven, highly efficient and cost effective method of conserving the variation within and between different plant species. Ensuring the long-term survival of the banked seed is only the beginning, research to determine and document the germination requirements for each species is critical.

To date the TSCC has collected 55.4 per cent of Tasmania's threatened flora and 936 plant species native to Tasmania. In alignment with Target 8 of the Global Strategy for Plant Conservation (GSPC), the TSCC's aim is to hold 75 per cent of the threatened Tasmanian flora by 2020, with an eventual goal to hold viable, multi-provenance collections for the storable Tasmanian flora (collections are considered storable when the seeds remain viable after being dried down to the low moisture levels required for long term storage). Prior to the establishment of the seedbank, the RTBG's holdings of threatened species were 138 plants from 20 taxa. At the beginning of 2014 seedbank collections of threatened flora stood at 7.2 million viable seeds from 243 taxa.

Much of Tasmania's flora is unique; of the 1915 known native vascular species, 522 (27 per cent) are endemic. Many Australian plants produce seeds that have complex dormancy systems requiring critical cues from the environment before they will germinate. Without an understanding of these requirements, conservationists cannot reasonably hope to reinstate lost or seriously depleted wild plant populations, or fully diverse habitats through land management practices or direct planting/sowing. Seed banking provides the knowledge base required to understand many of the complex germination requirements that these species demand. This work is highly significant as once germination requirements have been resolved this information can be readily shared and duplicated amongst the conservation community. Many habitat restoration programs are severely hampered by their inability to reinstate the complete vegetation of an area. For example trees, grasses and shrubs may be planted but some species that prove difficult to collect seed from, or are hard to germinate, are often excluded simply because there is no practical way of accessing material or propagating them. Such problems are often associated with common or keystone species, for example to date there is no reliable method of germinating seed from *Grevillea* spp., and the Rutaceae family is also problematic. Germination requirements of the majority of the Tasmanian flora have not been fully determined. The TSCC is actively working towards unlocking this critical information and making this resource available to the conservation community.

*Left: RTBG seed bank volunteer Laurel using a hand vacuum to collect seed of snow cushionplant (*Donatia novae-zelandiae*). Photo: N. Tapson*
Right: Seed Bank Manager James Wood and volunteer cleaning seeds. Photo: L. Perrins

In keeping with its principle of open disclosure, the RTBG consistently endeavours to make all its conservation data information publicly available as soon as practically possible. For example, the TSCC makes its germination testing data readily available to the general public via the *TSCC Germination Database* (www.rtbg.tas.gov.au/tasgerm). The database also provides an explanation of the science behind germination and seed dormancy, as well as how to apply germination techniques in the domestic situation, meaning this resource is not only being utilised by plant conservation professionals, but also by interested members of the public. The TSCC is also very active through its involvement with the National Australian Seedbank Partnership, in supporting an Australia-wide seed information database system, modelled on the RTBG initiative. The National Australian Seed Bank Partnership, governed by the Council of Heads of Australian Botanic Gardens, is a formal network of nine seed banks and five flora-focused organisations, bridging the gap between policy makers, researchers, seed collectors and on-ground conservation and restoration activities.

Although seedbanking has a proven record of being an extremely efficient *ex situ* conservation technique, there has been little on-going investment in this strategy to conserve Australia's flora for the long term. The TSCC relies heavily on a dedicated group of volunteers to operate successfully. Volunteers participate in all aspects of seedbanking work including field collecting, seed cleaning and germination testing. Approximately six volunteers provide an average weekly total of 30 hours per week and for the last eight years have contributed approximately 12,480 hours to the project. Many of the current volunteers have been with the TSCC since its inception. There is a constant need to source funds not only for the collection of seeds but also for the often complex studies required to resolve their specific germination requirements.

In late 2012 the TSCC received federal funding to collect and store seed from endemic conifers and restricted alpine flora occurring in the Tasmanian Wilderness World Heritage Area (TWWHA). The TWWHA contains a number of species at risk from climate change for which on ground management options are limited and *ex situ* conservation is currently non-existent or inadequate. The species collected were those most at risk from fire, increasing temperatures and moisture pressures. This project made 50 collections of 42 species, 21 of which were target species set by the grant. The project also provided species listing data and herbarium specimens from some of the most inaccessible and remote areas of Tasmania.

Many of Tasmania's threatened species are susceptible to the root-rot disease caused by cinnamon fungus (*Phytophthora cinnamomi*), which is spread via vehicles and bush walkers. The threat of future climate change is predicted to increase the suitable areas in which cinnamon fungus can penetrate and survive. Funding was received in 2013 to collect seed collections from vulnerable species and store them at the TSCC.

*Top: Seedbank Manager James Wood and volunteer collecting creeping strawberry pine (*Microcachrys tetragona*) at Marion's Lookout, Cradle Mountain–Lake St Clair National Park, Tasmania. Photo: L. Perrins*
Bottom: Seedbank Manager James Wood and Alpine Collector Karen Johnson assessing potential collecting targets growing on the edge of a small tarn above Lake Helios. Cradle Mountain–Lake St Clair National Park, Tasmania. Photo: T. Rudman

The TSCC hosts Tasmania's Threatened Orchid Conservation Program involving volunteers from the Friends of the RTBG and Threatened Plants Tasmania community groups. Tasmania has a very diverse orchid flora of over 200 species, one third of which are listed as threatened. This work concentrates on the storage and germination requirements. Orchids provide an extra challenge for seed banks due to their dependency on specialised relationships with fungi in order to germinate. Cultures of fungi are also required to be identified and maintained for each orchid species.

In the fight against plant extinction seedbanks are unique and valuable assets. Stored seeds can be used for restoration, research into climate change adaptation, prospecting for medicines, seeking traits in plant breeding and ultimately as an insurance policy. In a time of uncertainty regarding the ability for plant species to adapt to encroaching climate change and other threats, safely banking Tasmania's flora is a logical first step where virtually all species are at risk. The development of the TSCC has considerably expanded the RTBG's capacity to contribute meaningfully towards biodiversity conservation in Tasmania. Seed banking is the ultimate insurance policy for plants, providing a priceless resource for the future.

Conservation on a remote island: safeguarding the Macquarie Island Cushion Plant (*Azorella macquariensis*)

Lorraine Perrins and Natalie Tapson

Royal Tasmanian Botanical Gardens, Hobart, Tasmania. Email: Natalie.Tapson@rtbg.tas.gov.au

In 2012 *Australasian Plant Conservation* was very kind in allowing the Royal Tasmanian Botanical Gardens (RTBG) to post an appeal for funding to assist a very important conservation project on Macquarie Island. This article provides an update on that project and relays our gratitude to those who contributed to the project's appeal, enabling it to proceed.

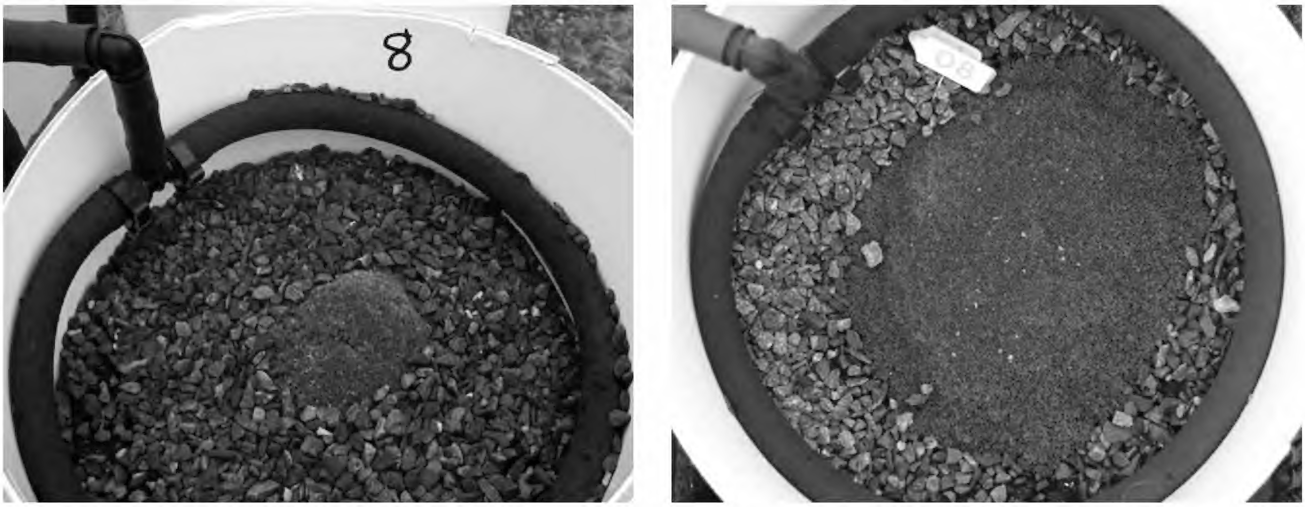
Macquarie Island lies in the 'Furious Fifties' approximately 1545 km southeast of Tasmania, and is an Australian Subantarctic Territory managed by the Tasmanian Government Parks and Wildlife Service. The Macquarie Island Cushion Plant (*Azorella macquariensis*), one of only four endemic plants on the island is considered to be the keystone species of the feldmark (a plant community on the sparse plateau uplands), which covers 45 per cent of the island. *Azorella* has undergone catastrophic decline since a dieback of unknown cause was first noted in 2008. This dieback is evident across the species' entire range, resulting in *A. macquariensis* being listed as a critically endangered species under national environment law.

In an effort to avoid extinction of this remarkable plant it was imperative that a viable *ex situ* collection be maintained. Although this could be achieved via seedbanking, it has not been possible to date to collect enough seed, and germinating the seed is proving to be very difficult. Maintaining individual plants as an *ex situ* collection at the RTBG was not possible due to difficulties in providing the environmental conditions required.

In March 2010, the RTBG set up a potted *ex situ* conservation collection on the island, but distant from wild populations. These plants are photographed every month during the growing season and, as can be seen from the images below, the plants are growing well four years later. This technique is considered a successful way of maintaining a protected collection of this species until the cause of the dieback can be resolved. The collection will also provide a reliable and easily accessible source of seed in the near future.

After a frantic two year period of grant-writing and fund-raising, the RTBG was successful in gaining sponsorship from the Mohamed bin Zayed Species Conservation Fund and the Foundation for National Parks and Wildlife which, in association with a number of individual donations (many of them from wonderful ANPC members), allowed us to plan for the expansion of these nine plants into a more genetically diverse collection.

In 2011 the RTBG applied to the Australian Antarctic Division (AAD) for a horticulturist to be included in the expedition to Macquarie Island for a three month period from November to January to expand the on-island, potted *ex situ* conservation collection from nine to 54 plants. The



Left: Azorella *plant 8 photo taken Summer 2010. Right:* Azorella *plant 8 photo taken Summer 2014.*
Photos: Tasmanian Parks and Wildlife Service

AAD administers all research and field work on Macquarie Island and expedition places during the busy summer period are hotly contested. After being initially unsuccessful in gaining an allocation for the 2012–2013 season, the project was lucky to be offered a short placement (only five weeks—a third of the time we had hoped for) to carry out this work from October–December 2013.

After some rigorous survival training on top of Mt Wellington in Hobart, RTBG horticultural botanist Natalie Tapson packed her bags and headed for Macquarie Island arriving on ‘Macca’ (as it is affectionately known) on 25 October 2013. Field training was a priority in the first weeks on the island. Safety in such a remote location is of the highest priority, and all arrivals are provided with an induction on safety procedures and intensive survival training, global positioning systems and compasses being essential tools of the trade; poor visibility is a common experience of Macca.

After that is was full steam ahead, unpacking and setting up the planting frames which had been transported down to the island last February, as well as collecting materials to create the potting medium in which the plants would be grown. Due to strict quarantine requirements, only autoclaved inorganic potting materials such as perlite and gravel were allowed to be shipped to Macca; all the remaining materials were collected from the island. This meant a lot of hard physical work collecting beach pebbles for drainage, digging peat, and transporting these materials to the top of Wireless Hill where the *ex situ* collection is located. As the plants are provided with supplementary watering in periods of no rainfall, an additional water tank and new irrigation lines also had to be fitted and connected.

Fortunately, Natalie was provided with an extra two weeks on the island due to delay of the supply ship *Aurora Australis* in sea ice during a resupply mission to Davis Station in Antarctica. This meant that with the wonderful support and assistance of staff from the Tasmanian Parks and Wildlife Service Rangers, the Macquarie Island Pest Eradication Team, staff from the Bureau of Meteorology and the Australian Antarctic Division, Natalie was able to complete the expansion of the conservation collection to 54 plants. These plants were collected from across Macquarie Island to maximise the likelihood of obtaining a broad cross section of genetically distinct individuals. This was a remarkable achievement in such a short period of time, and would not have been possible without much hard work and the generous assistance of so many on the island. Natalie’s words taken from her final report from the island sums it up nicely:

Natalie making up the potting media for the planting tubes on Wireless Hill. Photo: N. Tapson

View of Wireless Hill behind the Station buildings. Photo: N. Tapson

“*Well the job is almost done but in the end coming to Macquarie Island has been about much more than getting the job done. It is about the people and the place, about extremes and adaptability, about awe-inspiring landscapes and wildlife and over all those things is the weather. Ferocious winds, snow, hail, rain and since I have been here a fair amount of sunshine. I have been very privileged to be able to experience life on Macquarie Island and meet and work with the people here.*”

These ‘captive specimens’ will be closely monitored over the coming years and maintained as a conservation collection and source of seeds, whilst conducting further research to ensure the future preservation of this species.

Acknowledgments

Sincere thanks to the Mohamed bin Zayed Species Conservation Fund and the Foundation for National Parks and Wildlife for providing funds to undertake this project.

It's time for a Global Strategy for Plant and Fungus Conservation

Alison Pouliot[1], Tom May[2], Sapphire McMullan-Fisher[3], Peter Buchanan[4], Lyn Allison[5] and Jasmin Packer[6]*

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Introduction

The Global Strategy for Plant Conservation (GSPC) was initiated in 2002 to provide a framework for conserving botanical diversity worldwide under the Convention on Biological Diversity (CBD). The five objectives in the 2011–2020 GSPC include that plant diversity be well documented, effectively conserved and used in a sustainable manner. Among 16 specific targets under these objectives are an online flora and assessment of conservation status for known plant species as well as regional measures of conservation achievement. Earlier targets have already led to significant outcomes, such as creation of the *Plant List*, an 'accessible working list of known plant species' and multi-year funded capacity building initiatives.

The only mention of fungi in the GSPC states 'Parties, other Governments and other relevant stakeholders may consider developing conservation strategies for other groups such as algae and fungi...'. Optional development of strategies for fungal conservation, however, underestimates the importance of plant-fungal relationships, and undermines prospects for the GSPC to meet its conservation objectives. Specifically, if the GSPC is to meet its second objective—'Plant diversity is urgently and effectively conserved'—then all plant symbionts should be considered. At the same time, if fungi are incorporated into the GSPC on equal footing, this would turbo boost conservation of the fungal kingdom.

No plant is an island

The GSPC does not adequately acknowledge that all plants exist in beneficial relationships with fungi. Symbioses between plants and fungi are the norm, not the exception. The vast majority of plants form mutually beneficial mycorrhizal relationships with fungi, conferring access to nutrients as well as disease protection. All plants have fungal endophytes, some of which are mutualists, providing benefits to the plant host such as heat tolerance.

This level of dependency is taken to the extreme in the case of orchids. All orchids rely on fungi during the germination phase and many rely on fungi throughout their lives. It is not possible to address the conservation of orchids without proper consideration of their fungal partners.

The GSPC also insufficiently recognises the vital and unique roles of fungi in ecosystem function, providing ecosystem services such as decomposition and nutrient cycling, upon which all plants depend. Further to their roles as symbionts and recyclers, fungi are critically important for maintaining structure and improving water retention of the soils in which plants grow.

Left: Cortinarius austrocinnabarinus *is a mycorrhizal fungus forming mutually beneficial relationships with plants. Right:* Mycena epipterygia *is a saprobic fungus that provides essential ecosystem services through decomposition of plant matter. Photos: A. Pouliot*

Fungi in global and Australian biodiversity conservation

Interest in fungal conservation is growing. The International Society for Fungal Conservation was formed in 2010, with membership from more than 70 countries. The International Union for the Conservation of Nature (IUCN) now has five fungal specialist groups. While only three fungi appear among the 21,286 globally listed species on the 2013 IUCN Red List, a Global Fungal Red List Initiative has recently been implemented (Mueller and Dahlberg, 2013).

Despite growing awareness of fungal biodiversity, the CBD categorises life forms as animals, plants or members of the arbitrary non-taxonomic category of micro-organisms, and hence does not adequately accommodate fungi (Minter 2011). Similar shortcomings exist in Australian conservation strategies (Pouliot and May 2010). Australia's *National Biodiversity Strategy 2010-2030*—a requirement of being CBD signatory—does not explicitly deal with fungi. The one conservation overview specifically dealing with fungi—the 1997 *Conservation overview of Australian non-marine lichens, bryophytes, algae and fungi*—was never implemented.

Australia has 11 846 described species of fungi (Chapman 2009) and the total number is expected to exceed that of the plant kingdom by up to ten times. Conservation status is unknown for all but a handful. There are 1295 species of plants listed under the *Environment Protection and Biodiversity Conservation Act 1999*, but only two species of fungi. However, the fungi are listed not for protection, but as threatening processes. Likewise, the few Australian conservation strategies that include fungi do so mostly in the context of fungi as threatening processes, rather than as organisms themselves requiring explicit protection.

A more inclusive strategy for biodiversity beyond the animal kingdom

How can we improve the conservation of both plants and fungi? Griffith (2012) presented a compelling case for a global conservation strategy for microorganisms, under which he included fungi. However, we consider it better to recognise fungi as the second largest kingdom of life and hence a significant component of biodiversity, rather than lumped among the poorly defined 'microbes' that typically include bacteria and microscopic fungi.

Reinventing the wheel and developing a strategy solely for fungi is probably not the most efficient or best approach. Rather, a strategy that includes plants, algae and fungi is proposed to acknowledge taxonomic, trophic and ecological diversity and incorporate interactions between kingdoms. The *International Code of Nomenclature for Plants, Algae and Fungi* adopted at the Melbourne International Botanical Congress in 2011 is a useful model for explicit inclusion of organisms across kingdoms.

Hypocreopsis amplectens *is one of the very few Australian fungi formally listed on conservation schedules (Victorian Flora and Fauna Guarantee Act 1988). Photo: T. May*

Considering plants, algae and fungi in tandem capitalises on existing programs in key institutions such as botanic gardens and other government biodiversity and research organisations, and avoids introduction of unnecessary duplication of scarce organisational resources. Fungal conservation is way behind plant conservation and future collaborations could bring the treatment of fungi into alignment with that for plants, mirroring the interdependencies of organisms in nature.

The time is nigh

The GSPC drives plant conservation activities at global, regional, national and local levels. If plants and their partners are to be effectively conserved, an integrated strategy is needed. A *Global Strategy for Plant, Algal and Fungal Conservation* implemented from 2020 would combine knowledge and resources in a more systematic and inclusive approach to conserving biodiversity.

Mycologists and fungal conservationists will likely be the driving force in developing a more inclusive strategy. However, broader public and political support is necessary to turn concern into policy. The GSPC vision states that 'Without plants, there is no life'. Without fungi, there is also no life. The importance of plant-fungus relationships can no longer be overlooked and plant conservation needs to become systematically inclusive of fungi if it is to meet GSPC objectives.

References

Chapman, A.D. (2009). *Numbers of Living Species in Australia and the World.* Australian Biodiversity Information Services, Toowoomba, Australia. p. 80.

Griffith, G.W. (2012). Do we need a global strategy for microbial conservation? *Trends in Ecology and Evolution* 27: 1-2.

Minter, D. (2011). Fungal conservation needs help from botanists. *Plant Biosystems* 145: 945-949.

Mueller, G.M. and Dahlberg, A. (2013). The global fungal red list initiative. *Inoculum* 64: 1-2.

Pouliot, A.M. and May, T.W. (2010). The third 'F' – fungi in Australian biodiversity conservation: actions, issues and initiatives. *Mycologica Balcanica* 7: 41-48.

ANPC Member profile

Steve Clarke

Workplace: University of Western Sydney, Hawkesbury Campus, Richmond NSW
Role: Senior Technical Officer / Farm Supervisor

What projects are you working on at the moment?

I have been working full time in the Horticulture facility at the University of Western Sydney (UWS) for 28 years now. My role has mostly involved the management of a range of flower, vegetable and tree crops (including some native species). Twelve months ago my role was expanded to include supervision of our grazing and broad acre cropping enterprises as well. There's plenty of tractor work involved and I demonstrate activities such as soil preparation, crop maintenance, how to calibrate spray equipment, and how to prune a range of crop species for the students.

There were limited to non-existent opportunities for plant conservation work until about 18 months ago when UWS and Greening Australia NSW entered into a partnership to establish a regional seed production facility. This is already producing quantities of high quality, genetically diverse seed from a wide range of Cumberland Plain Woodland species, specifically grasses and herbaceous wildflowers (forbs) for use in restoration projects. It will also provide educational opportunities for the students and some research spin offs. My main involvement so far has been all the tractor work in preparing the sites (some are on flat ground whilst others are in raised beds), early crop establishment, maintenance operations such as irrigation, and a range of strategic weed management interventions. I hope to eventually get more involved in the seed harvesting and processing as well.

I am also employed as a casual field officer for the NSW National Parks and Wildlife Service (NPWS). In this capacity, I am heavily involved with the *in situ* research and ecological monitoring of the wild Wollemi Pine (*Wollemia nobilis*) populations in Wollemi National Park and as a member of the Wollemi Pine Recovery Team. Several times a year I visit the wild trees and undertake a range of studies. I was there just a few weeks ago collecting propagation material for the *ex situ* collection held at the Australian Botanic Garden at Mt Annan and a genetic study of the trees. This is all on an 'as needs' basis during weekends and while on leave from UWS.

How long have you been involved in the ANPC?

I've been a member of ANPC for five years now. My main motivation was to add my voice to the cause as well as support the work that the ANPC does. I believe the number of members an organisation represents has an impact, especially at the political level. I attended the ANPC Conference in Mulgoa in 2008, the seed collection workshop at Mt Annan, one of the myrtle rust workshops and have contributed three articles to APC in the last year.

Steve Clarke in Sydney sandstone country.
Photo: Steve Clarke

How did you end up working in plant conservation?

I define myself as an 'exploratory bushwalker' who practices horticulture to pay his living expenses! I spend most of my spare time undertaking exploratory bushwalks (off track in remote areas using compass navigation), mainly in the Blue Mountains and Wollemi National Parks. It has been through this pastime that I've become very interested and involved in threatened species conservation.

In particular, I was inspired by a specific event which I can remember vividly like it was yesterday. In May 2001, I was on one of my regular exploratory trips when I discovered a grove of Wollemi Pine trees. At first I thought it must have been one of the known sites but quickly suspected it was a new site. When I got home I contacted the Royal Botanic Gardens, Sydney and they confirmed that it was a new site. It was very exciting. Anyway, that event led to my casual employment with NPWS.

What conservation activities are you involved with in your spare time?

Once the initial excitement of finding the Wollemi Pines was over, I started thinking to myself 'well what else might I have walked past in all these years?' It really sharpened my focus, and I started really looking at the plants I was walking past on my walks. Anyway, within a couple of months I started making some important finds of threatened plant species, which represented significant increases in the numbers of sites, population sizes and range extensions. So it went on from there and became a keen interest. The Botanic Gardens issued me with a scientific licence to collect herbarium specimens and I commenced documenting sites containing threatened species I came across during my walks. It's been a very handy partnership because I'm out there anyway and the NPWS and Royal Botanic Gardens really don't have the resources.

In 2005 the NSW Scientific Committee contacted me and asked if I'd keep an eye out for the endangered shrub *Apatophyllum constablei* which was only known from four small sites in Wollemi National Park. A couple of years prior to this, all the known populations had been burnt by a high intensity wildfire. As nothing was known of its fire ecology there were fears held for its survival. By a happy coincidence it was an area I had recently started to explore. I relocated three of the original populations and quickly discovered that it was a re-sprouter and that seed germination was cued by fire. I also found many new sites representing a considerable range extension. When the Scientific Committee applied the IUCN criteria to the data I had collected, they were able to take it off the threatened species list!

In June 2003 I was in a spectacularly rugged part of Wollemi National Park and there on a narrow ledge were some plants covered in beautiful yellow flowers that I hadn't seen before. It turned out to be a new species which is confined to a very restricted area of niche habitat. Along with three co-authors we formally described it as *Leionema scopulinum*.

Several times a year I head out on field trips with Richard Johnstone from the NSW Seed Bank, collecting seed from a range of threatened species. Richard needs the seeds for the Seed Bank and I know where the plants are! In addition, last year I was asked to assist with the development of Priority Action Statements for some of the threatened species I have found.

Eight years ago I bought a 25 acre property close to Capertee, Gardens of Stone and Wollemi National Parks. It contains high quality white box grassy woodland which I am managing for its ecological values. And it is a useful base for my walking trips!

Overall, it has been a very eventful and rewarding 13 years since I found the new Wollemi Pine site, basically turning what was an indulgent past time into an opportunity to provide what I hope has been a tangible contribution to the conservation of some of our threatened plant species.

Interviewed by Jo Lynch, Business Manager, Australian Network for Plant Conservation, Canberra

Projects in focus

ANPC Orchid Conservation Program

Tricia Hogbin

Australian Network for Plant Conservation, Email: projects@anpc.asn.au

The Australian Network for Plant Conservation (ANPC) recently announced its new Orchid Conservation Program. The program focuses on the management, *ex situ* propagation and reintroduction of threatened orchids, particularly across south eastern Australia. The Orchid Conservation Program is an exciting development for the ANPC as it provides an opportunity for the organisation to practice what it preaches and demonstrate best-practice plant conservation.

*Tawny Spider-orchid (*Caladenia fulva*), one of five threatened orchids being propagated for a translocation project implemented in partnership with Wimmera CMA. Photo: Noushka Reiter*

The program has a long history and recently transitioned to the ANPC from Wimmera Catchment Management Authority (CMA) in Victoria. The ANPC is looking forward to working with Wimmera CMA and the many other organisations and community groups that have been involved in the implementation of this project to date.

The program is led by Dr Noushka Reiter, who has over 14 years' experience in threatened flora management and has been with the Orchid Conservation Program for the past seven years. Nouskha commenced employment with the ANPC in January and is based in Horsham where the ANPC now manages a nursery and laboratory facility. A team of volunteers support Noushka in the lab, including regular volunteer Wendy Bedggood (who generously volunteers one day a week) and also Mary Argall and Gail Pollard.

For more information visit http://www.anpc.asn.au/projects/orchids.html

Restore and Renew NSW: Online survey of NSW restoration practitioners identifies species considered most useful in restoration

Tricia Hogbin[1] and Maurizio Rossetto[2]

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An online survey of NSW restoration practitioners guided the development of a list of 232 plant species considered most useful in restoration projects across NSW. These species will be included in the next stage of the Restore and Renew NSW project, a new collaborative project led by the Royal Botanic Gardens and Domain Trust.

Restore and Renew NSW will develop research-based, detailed and specific restoration guidelines for over 200 plant species which are considered the most effective in restoration projects across NSW. Genetic, adaptive, environmental, and ecological information will be collected for all 200+ species by taking advantage of innovative research techniques. For example, Next Generation Sequencing, a technique similar to that used in the 'Human genome project', will be used to collect genetic information on a scale never before attempted in plants. Obtaining detailed information for an unprecedented number of species will also help identify broader landscape-level patterns as well as predictive generalisations that can be applied across many other species used in restoration. To maximise the relevance and applicability of research outcomes, restoration practitioners were consulted through an online survey when developing the list of species to include in Restore and Renew NSW.

Online practitioner survey

The online survey was conducted between September–December 2013 and received a total of 247 responses. The survey targeted anyone involved in native vegetation restoration projects in NSW. The most frequent roles of respondents in restoration were 'restoration practitioner/ bush regenerator', 'project manager', 'community volunteer' and 'grower/supplier/seed collector'. The survey was widely promoted through the ANPC (including through *Australasian Plant Conservation*, the ANPC NEWS email newsletter and social media) and the networks of a range of other relevant organisations including the Australian Association of Bush Regenerators, Local Land Services, Local Government and Shires NSW, and the Ecological Consultants Association of NSW.

One of the key objectives of the survey was to identify which species are 'most commonly used' in restoration and revegetation projects across NSW. A total of 730 species were identified as 'commonly used' by 147 respondents. Survey respondents were also provided with a summary of the type of information the Restore and Renew NSW project aims to provide (e.g. where to source material and minimum number of individuals to collect seed from to maximise genetic diversity) and asked how useful they thought this information would be. 86.4 per cent of survey respondents claimed the information would be 'extremely useful', 'very useful; or 'useful'.

The 20 most frequently used species in NSW restoration projects as revealed by an online survey of 147 NSW restoration practitioners.

Species common name	Species scientific name	Frequency of mention by survey respondents
Spiny-headed Mat-rush	*Lomandra longifolia*	90 (61%)
Sydney Golden Wattle	*Acacia longifolia*	52 (35%)
Blue Flax-lily	*Dianella caerulea*	52 (35%)
Kangaroo Grass	*Themeda australis*	47 (32%)
Weeping Grass	*Microlaena stipoides*	38 (26%)
Purple Coral Pea	*Hardenbergia violacea*	35(24%)
Forest Red Gum	*Eucalyptus tereticornis*	31 (21%)
Blackthorn	*Bursaria spinosa*	30 (20%)
Large-leaf Hop-bush	*Dodonaea triquetra*	30 (20%)
Coast Banksia	*Banksia integrifolia*	30 (20%)
Lilly Pilly	*Acmena smithii*	26 (18%)
Australian Indigo	*Indigofera australis*	24 (16%)
Prickly Moses	*Acacia ulicifolia*	23 (16%)
Tick Bush	*Kunzea ambigua*	23 (16%)
Black She-oak	*Allocasuarina littoralis*	23 (16%)
Sandpaper Fig	*Ficus coronata*	23 (16%)
Hickory Wattle	*Acacia implexa*	22 (15%)
Tall Sedge	*Carex appressa*	22 (15%)
Swamp Oak	*Casuarina glauca*	22 (15%)
Tassel Sedge	*Juncus usitatus*	22 (15%)

Projects in focus (cont.)

Expert workshop

An expert workshop was held in March 2014 to refine the list of 730 species identified by respondents to approximately 250 species. The refinement of the list took into account frequency of use of species by practitioners as well as the need to capture sufficient geographic, environmental and functional diversity. For example, the 'top 20' listed in Table 1 is biased towards the greater Sydney region, because 46 per cent of respondents were from this area. This final list of 232 species includes species from across NSW and can be found at http://anpc.asn.au/projects/RestoreNSW.html.

Where to next for Restore and Renew NSW?

The Restore and Renew NSW project is taking the innovative and exciting approach of using citizen scientists to collect plant material from a large number of sites spanning NSW. Using citizen science collection teams actively engages the community and increases the feasibility of such an extensive sampling program. Regional citizen science collection teams will receive training in plant identification and the collection of leaf material for DNA testing.

Priorities over the coming months include the design of the sampling strategy, establishment of citizen science collection teams and securing funding for this large-scale project. Anyone interested in being involved can contact the authors.

Participants of an expert workshop where the outcomes of the online survey were reviewed to identify a list of 232 species to include in the Restore and Renew NSW project. From left to right: Peter Cuneo, Michelle Leishman, Linda Broadhurst, Chris Allen, Maurizio Rossetto, Doug Benson, Andrew Denham, Tony Auld. Photo: Tricia Hogbin

Upcoming conferences and workshops

XIIth Australian Bryophyte Workshop

29 June–4 July 2014
Mackay, Queensland

The Australian Bryophyte Workshop is held biennially in a different region of Australia. This year's workshop is being held in the Mackay and includes daily trips to sites throughout the Mackay/Whitsunday region. Email Andrew Franks: andrew.franks@o2ecology.com.au for further information.

Island Biology 2014. An International Conference on Island Evolution, Ecology, and Conservation

7–11 July 2014
Hawaii, USA

This will be the first of a regular series of meetings that will be held every four years, on islands around the world, at which island biologists can come together, share insights, and develop collaborations that will accelerate the pace and effectiveness of island research and conservation. Meetings will be held at the conference to establish the International Society for Island Biology (ISIB) and its scientific journal, Island Biology.

For more information visit https://sites.google.com/a/hawaii.edu/islandbiology2014/

Society for Conservation Biology Oceania 2014 conference

9–11 July 2014
Suva, Fiji

The Oceania Section of the Society for Conservation Biology represents the Australia, New Zealand, and Pacific Island regions. The 2014 conference will be held in Fiji and provides opportunities for researchers to present their work in focused symposia related to the main conference themes:

- vulnerable ecosystems, communities and species
- adaptive and community based management of socio-ecological systems
- conservation in a changing oceania.

For more information visit http://www.scbo2014.usp.ac.fj/

Upcoming conferences and workshops (cont.)

Australasian Network for Ecology and Transport Inaugural conference

20–23 July 2014
Coffs Harbour, New South Wales

The Australasian Network for Ecology and Transport (ANET) is a professional network for all people involved in the planning, design, construction, maintenance and research of linear infrastructure and the environment. The impacts of linear infrastructure and the vehicles they carry are considerable and are responsible for the mortality of hundreds of thousands of animals each year, the decline of populations and disruption to ecosystem function. The conference aims to provide practical tools for the design, construction and management of environmentally-friendly linear infrastructure. The topics covered will range from incorporating research and monitoring into infrastructure design, designing offsets and mitigation and the opportunities and challenges facing road agencies and construction teams.

For more information visit http://ecoltrans.net/anet-conference-2014/

2014 Government Sustainability Conference

12–13 August 2014
Sydney, New South Wales

The 2014 Government Sustainability Conference will provide delegates from local, state and federal government and the wider public sector with comprehensive analysis and advice on how to address crucial environment issues and embed sustainability within their organisations. This annual national conference will provide valuable networking opportunities and the ability to learn from leading sustainability practitioners in the public sector.

For more information visit http://commstrat.cvent.com/d/g4q9l8

19th Australasian Weeds Conference

1–4 September 2014
Hobart, Tasmania

The Tasmanian Weeds Society, in conjunction with the Council of Australasian Weeds Societies Inc. will host the 19th Australasian Weeds Conference. This conference will focus on the conference theme of ‘Science, Community and Food Security: the Weed Challenge’. For more information visit http://australasianweeds2014.com.au/

Ecological Society of Australia 2014 Annual Conference

28 September–3 October 2014
Alice Springs, Northern Territory

The conference features symposia on regionally relevant issues such as arid ecology and Indigenous ecological knowledge. It will also cover the full range of biomes, from deserts to oceans, and embrace all aspects of ecological theory and practice. The conference includes a diverse range of symposia topics, including: integrating conservation with food production through off-reserve conservation; monitoring for managing biodiversity; and evolution, ecology and management of spinifex grasslands.

For more information visit http://www.esa2014.org.au/

Botanic Gardens of Australia and New Zealand Biennial Conference

2–4 October 2014
Cairns, Queensland

The Botanic Gardens Australia and New Zealand promotes the interests and activities of Australian and New Zealand botanic gardens and botanic gardens generally and enhances the state of botanic gardens for the benefit of the community. This year’s conference theme is ‘cultivating connections’.

For more information visit http://www.bganz.org.au/

10th Australasian Plant Conservation Conference

12–14 November 2014
Hobart, Tasmania

The 10th Australasian Plant Conservation Conference, hosted by the Australian Network for Plant Conservation and the Royal Tasmanian Botanic Gardens, will provide a forum for conservation practitioners, community members and the scientific community to interact at a practical level. The overall theme of the 2014 conference is ‘Sustaining Plant Diversity – Adapting to a Changing World’. Sub-themes include: securing biodiversity; prioritising actions; animals in plant conservation and engagement; and communication in the modern world.

For more information visit http://www.anpc.asn.au/conferences/2014/

Upcoming conferences and workshops (cont.)

IUCN World Parks Congress

12–19 November 2014
Sydney, New South Wales

The IUCN World Parks Congress 2014 is a landmark global forum on protected areas. The Congress will share knowledge and innovation, setting the agenda for protected areas conservation for the decade to come. Building on the theme 'Parks, people, planet: inspiring solutions', it will present, discuss and create original approaches for conservation and development, helping to address the gap in the conservation and sustainable development agenda.

For more information visit
http://www.worldparkscongress.org/

Website review

Weed futures: determining current and future weed threats

www.weedfutures.net
Lesley Hughes et al. 2013
Online resource with full report available for downloading in PDF format

In the past, if one wished to gather information on an invasive plant's identity, biology and/or distribution, or on options for its management, one consulted a book. Depending on your years since graduation, you consulted volumes such as Auld and Medd (1987) or more lately Richardson et al. (2006) or, if you knew it was a declared noxious weed, then the second edition of Parsons and Cuthbertson (2001). These were essential references for a previous generation of weed scientists. But more recently, web sites have become available that save a walk to the library or even a reach to get the volume from your shelves. An increasing number of web sites are now available on a wide range of invasive plants, whether on Weeds of National Significance, weeds of research interest (e.g. to the former Weeds Cooperative Research Centre), or on other such categories of those invasive plant species we call 'weeds'.

The latest in this continuing series of aids to weed information is the website *Weed Futures*, which is contributed to by nine weed scientists, with complementary skills and backgrounds in environmental science, five of whom work at Macquarie University. The invasion process has three defined states along a continuum from introduced to naturalised to invasive (i.e. weed). *Weed Futures* enables the user to search by region or by species for a total of 292 non-native naturalised plant species that are not yet known to be invasive, i.e. they are at the middle stage of this continuum of change. All 292 species are rated at both national and state levels in terms of the current and future threats each species may pose to a changing environment. The site is designed to prioritise the species in relation to various threats, and especially future threats from changing regimes of climate in increasing their potential to become invasive.

All of us who deal with invasive plant species, in whatever way, have our pet 'hates' as well as our tolerances of some naturalised plant species that don't appear to be causing any threat to native vegetation. My pet hates are currently *Agapanthus* and *Gazania*, both of which feature in the group of 292 species. But it came as a surprise to find Wild Oats (*Avena fatua*) listed in what is—as stated—a listing of non-native naturalised plants that have yet to become invasive. Wild Oats is definitely a major invader, not just of agricultural cropping land but also of roadsides and, more significantly, of *Themeda* grassland in southeastern Australia. For example, in 2003 it was estimated to cost Australian grain growers $150 million every year. This error needs to be corrected, to list it as already invasive, as indeed some weed scientists would claim for *Agapanthus* in both southwest Western Australia and the Blue Mountains region of New South Wales.

The site has been designed as a decision tool for land managers. The authors encourage feedback from users, so that presumably it can be refined progressively as new knowledge becomes available; a laudable aspect I believe of the overall approach taken. But the essence of this website is to come up with ratings of species with 'low', 'medium' or 'high' potential for population increase and expansion of habitat by 2035 and 2065. The validity of such future projections depends in turn on the rigour of the information in the 25 national and international plant databases that were used, a qualification that applies to all such modeling attempts.

This website seems to me a useful one, both for weed biologists to understand the species they are dealing with and for land managers to devise management plans for delimiting the impact of the 'weeds' they wish to control. The books I cited above rarely indicated how a plant's distribution would change with changing environments or even changing land uses (such as the change from

Website review

frequent to minimal cultivation of agricultural land). The website *Web Futures* is devoted to estimating how present distributions will change in the future. Users will thus gain some insight into the dynamic nature of plant populations and, hopefully, some understanding of the factors that may influence the change in status from naturalised to invasive, especially in terms of postulated climatic changes. If this web site increases knowledge about such a change in status it will be more than worthwhile in my opinion.

For the plant conservation audience, use of this website will increase understanding, I hope, of the interplay between changing climates, changing plant populations and even the dynamics of the plant communities in which species (both native and non-native) co-occur. The increased understanding is somewhat of a tall order but will be essential I believe to better manage Australian vegetation types by 2035, let alone 2065. At the very least, users will become familiar with likely future scenarios for species in which they have a current interest. For invasion ecologists its use will aid understanding of the change in status from naturalised to invasive for a range of 292 non-native plants. The latter number is only about a tenth of the total number of naturalised plants in Australia. But a start has to be made somewhere and this recent attempt seems to me to be a worthwhile exercise that should attract wide attention from a diverse audience of people interested in Australian plant ecology and vegetation management. I recommend you browse it, perhaps download it - and, more importantly, use it!

Richard Groves, Honorary Research Fellow, CSIRO Plant Industry, Canberra

References

Auld, B.A. and Medd, R.W. (1987). Weeds. *An illustrated botanical guide to the weeds of Australia.* Inkata Press, Melbourne.

Parsons, W.T. and Cuthbertson, E.G. (2001). *Noxious Weeds of Australia, 2nd edn.* CSIRO Publishing, Melbourne.

Richardson, F.J., Richardson, R.G. and Sheppard, R.C.H. (2006). *Weeds of the South-east. An identification guide for Australia.* R.G. & F.J. Richardson, Meredith, Victoria.

Information resources and useful websites

Start with the grasslands: design guidelines to support native grasslands in urban areas

http://tinyurl.com/startwithgrasslands

This free best-practice manual was produced by the Victorian National Parks Association and provides guidance for the design and management of native grasslands (both large and small) within the urban context to maximise environmental and social outcomes. The manual is intended for use by practitioners, project teams, contractors, educators, friends groups, land managers, government authorities and other interested parties to support the design of new developments. Ecologist Ian Lunt describes the guidelines as “the most innovative and ground-breaking book on urban grassland conservation ever produced in Australia” and describes the content as being “relevant to any fragmented ecosystem”. The guidelines will be especially useful for community members wanting to lobby more effectively for best-practice urban design around grasslands and other native vegetation remnants.

The Australian Plant Name Index

http://www.anbg.gov.au/databases/apni-about/

The *Australian Plant Name Index* online database is a tool for the botanical community that deals with plant names, not only those in current use, but also those names used in the past. It is a useful tool for checking that you are using the correct and current scientific name for an Australian plant. Information provided includes: names in current use, plant name changes, previous names for a renamed plant, the journal or place where the name was formally published, the author of the plant name, and the place in Australia where the Type specimen was collected.

In Safe Hands Toolkit

http://insafehandstoolkit.com.au/

The *In Safe Hands Toolkit* was developed by Conservation Volunteers Australia and provides guidance to community groups engaged in practical conservation activities to eliminate or minimise the associated risks and meet duties under Work Health and Safety legislation. The comprehensive toolkit includes a suite of practical guidelines and templates.

Research round up

Compiled by Kirsten Cowley

Centre for Plant Biodiversity Research, Canberra. Email: Kirsten.Cowley@csiro.au

Banks, S.C., Cary, G.J., Smith, A.L., Davies, I.D., Driscoll, D.A., Gill, A.M., Lindenmayer, D.B. & Peakall, R., (2013). **How does ecological disturbance influence genetic diversity?** *Trends in Ecology & Evolution* 28(11): 670-679. http://dx.doi.org/10.1016/j.tree.2013.08.005

Bartle, K., Moles, A.T. & Bonser, S.P. (2013). **No evidence for rapid evolution of seed dispersal ability in range edge populations of the invasive species *Senecio madagascariensis*.** *Austral Ecology* 38: 915-920.

Boutin, C., Strandberg, B., Carpenter, D., Mathiassen, S.K. & Thomas, P.J. (2013). **Herbicide impact on non-target plant reproduction: What are the toxicological and ecological implications?** *Environmental Pollution* 185: 295-306.

Doak, D.F., Bakker, V.J., Goldstein, B.E. & Hale, B. (2014). **What is the future of conservation?** *Trends in Ecology & Evolution* 29(2): 77-81.

Geerts, S., Moodley, D., Gaertner, M., Le Roux, J.J., McGeoch, M.A., Muofhe, C., Richardson, D.M. & Wilson, J.R.U. (2013). **The absence of fire can cause a lag phase: The invasion dynamics of *Banksia ericifolia* (Proteaceae).** *Austral Ecology* 38: 931-941.

Gooden, B. & French, K. (2014). **Impacts of alien grass invasion in coastal seed banks vary amongst native growth forms and dispersal strategies.** *Biological Conservation* 171: 114-126.

Guerrant, E.O. Jr, Havens, K. & Vitt, P. (2014). **Sampling for effective ex situ plant conservation.** *International Journal of Plant Sciences* 175(1): 11-20.

Koutsovoulou, K., Daws, M.I. & Thanos, C.A. (2014). **Campanulaceae: a family with small seeds that require light for germination.** *Annals of Botany* 113: 135-143.

McCaffrey, N.B., Blick, R.A.J., Glenn, V.C., Fletcher, A.T., Erskine, P.D. & van Osta, J. (2014). **Novel stratified-meander technique improves survey effort of the rare Pagoda Rock Daisy growing remotely on rocky cliff edges.** *Ecological Management & Restoration* 15(1): 94-97.

McCallum, K.P., Guerin, G.R., Breed, M.F. & Lowe, A.J. (2014). **Combining population genetics, species distribution modelling and field assessments to understand a species vulnerability to climate change.** *Austral Ecology* 39(1): 17-18.

Murphy, B.P., Taylor, C.M., Heath, M., Gibbs, J. & Petit, S. (2013). **Ground cover two years after prescribed fire in stringybark open forest at Bagdad Native Forest Reserve, Robe, South Australia.** *The South Australian Naturalist* 87(2): 85-89.

O'Loughlin, L.S., Green, P.T. & Morgan, J.W. (2014). **What potential is there for regeneration of native species from the soil seed bank in Coast Tea Tree-dominated scrub?** *Ecological Management & Restoration 15(1): 80-83.*

Radford, J. (2014.) **The role of private conservation in saving biodiversity in Australia.** *Ecological Management & Restoration* 15(1): 2-3.

Ritchie, E. G., Bradshaw, C.J.A., Dickman, C. R., Hobbs, R. Johnson, C. N., Johnston, E.L., Laurance, W.F., Lindenmayer, D. McCarthy, M.A., Nimmo, D.G., Possingham, H.H., Pressey,R.L., Watson, D.M. & Woinarski, J. (2013). **Continental-scale governance and the hastening of loss of Australia's biodiversity.** *Conservation Biology* 27:1133-1135.

Sinclair, S.J., Duncan, D.H. & Bruce, M.J. (2014). **Mortality of native grasses after a summer fire in natural temperate grassland suggests ecosystem instability.** *Ecological Management & Restoration* 15(1): 91-94.

Sutherland, W.J., Aveling, R., Brooks, T.M., Clout, M., Dicks, L.V., Fellman, L., Fleishman, E., Gibbons, D.W., Keim, B., Lickorish, F., Monk, K.A., Mortimer, D., Peck, L.S., Pretty, J., Rockstrom, J., Rodriguez, J.P., Smith, R.K., Spalding, M.D., Tonneijck, F.H. & Watkinson, A.R. (2014). **A horizon scan of global conservation issues for 2014.** *Trends in Ecology & Evolution* 29(1): 15-22.

Williamson, G.J., Murphy, B.P. & Bowman, D.M.J.S. (in press). **Cattle grazing does not reduce fire severity in eucalypt forests and woodlands of the Australian Alps.** *Austral Ecology* doi:10.1111/aec.12104.

Wilmshurst, J.M., Moar, N.T., Wood, J.R., Bellingham, J.R., Findlater, A.M., Robinson, J.J. & Stone, C. (2013). **Use of pollen and ancient DNA as conservation baselines for offshore islands in New Zealand.** *Conservation Biology* 28(1): 202-212.

Yelenik, S.G. & D'Antonio, C.M. (2013). **Self-reinforcing impacts of plant invasions change over time.** *Nature* 503: 517-520. doi:10.1038/nature12798

Research round up

Young, J.C., Waylen, K.A., Sarkki, S., Albon, S., Bainbridge, I., Balian, E., Davidson, J., Edwards, D., Fairley, R., Margerison, C., McCracken, D., Owen, R., Quine, C.P., Stewart-Roper C., Thomspon, D., Tinch, R., Van den Hove, S. & Watt, A. (2014). **Improving the science-policy dialogue to meet the challenges of biodiversity conservation: having conversations rather than talking to one-another.** *Biodiversity and Conservation* 23(2): 387-404.

Zimmer, H.C., Auld, T.D., Benson, J. & Baker, P.J. (2014). **Recruitment bottlenecks in the rare Australian conifer *Wollemia nobilis*.** *Biodiversity and Conservation* 23(1): 203-215.

Zylstra, P. (2013). **The historical influence of fire on the flammability of subalpine Snowgum forest and woodland.** *The Victorian Naturalist* 130(6): 232-239.

Contributions to Research Roundup are welcome, and should be sent to Kirsten Cowley at the above email address using an email subject heading "APC Research Roundup" or similar. Their inclusion will be subject to available space.

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KEYNOTE SPEAKER:

Professor Ian Lunt,
Charles Sturt University

PLENARY SPEAKERS:

Professor David Bowman,
University of Tasmania

Dr Terry Walshe,
University of Melbourne

Professor Jonathon Majer,
Curtin University

Andrew Smith, Tasmanian Parks
and Wildlife Service

Photos (left to right): *Tetratheca gunnii*, a Tasmanian endangered species; *Richea scoparia*, an abundant alpine plant endemic to Tasmania. Photos: Royal Tasmanian Botanical Gardens